

SEPEC Conference Series

P R O C E E D I N G S



Technology & Methods for Developing Networks

(NASA-CR-188124) NETWORKING AS A STRATEGIC
TOOL, 1991 (Research Inst. for Advanced
Computer Science) 189 p CSCL 09B

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Conference

April 30, 1991

Nassau Bay Hilton on Clear Lake
Houston, Texas

Co-Sponsored by

NASA/Johnson Space Center
University of Houston-Clear Lake
Network Working Group



Research Institute for Computing and Information Systems

University of Houston

SEPEC
Software Engineering Professional Education Center

Clear Lake

2700 Bay Area Boulevard, Box 258
Houston, Texas 77058-1088
713 • 282-2223

Greetings, Networking Professional!

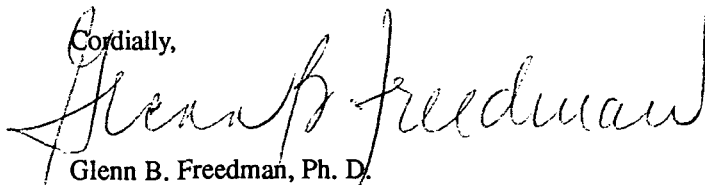
On behalf of the conference steering committee, the Software Engineering Professional Education Center, the Research Institute for Computing and Information Systems, and the University of Houston - Clear Lake, I would like to thank you for your interest in our conference in the work of the conference participants, as exemplified by this outstanding set of presentations and papers. We welcome your comments and hope that you will consider attending future programs that the university sponsors.

Discussions and presentations about networking strategies are especially timely in a period of time in which we are witnessing explosive technical changes, organizational changes, and interest in networking balanced by the harsh light of budget constraints, implementation and maintenance costs, schedule overruns, and training demands. The balancing act that each technical and managerial participant to the conference faces is played out internationally as well. Obviously, we cannot solve the world's problems, but we can make a stab at addressing those of the region. Perhaps all of the answers won't be found, but at least we can say that the discussions have begun in earnest, that the our community is willing to ask the tough questions, and that we have the talent to address the questions.

Your interest and willingness to join us in network strategy discussions has led us to consider on-going programs designed to bring the community together, using the university as a platform, for informed consideration of key issues. The level of cooperation among industry, government, and academic leadership in networking to produce this conference is a testament to the capabilities of the community. We at the university are prepared to build on the initiative and make it viable for the long term. Your ideas are the basis of the growth, so let us know your ideas.

Again, thanks for your participation and interest. Enjoy! And to paraphrase the proverb: May the wisdom of the conference speakers be beneficial to your lives.

Cordially,



Glenn B. Freedman, Ph. D.
Director, Software Engineering Professional Education Center
Dean, Professional and Continuing Education

The Networking Conference

sponsored by NASA/JSC and UH-Clear Lake, focuses on the technological advances, pitfalls, requirements, and trends involved in planning and implementing an effective computer network system. With today's proliferation of powerful machines and networks, engineers and managers need the practical knowledge of the complexities to make informed decisions in evaluating, planning, and implementing network systems. The management skills

will also be needed to facilitate the human factor for the smooth operation of an in-place network. A sophisticated and workable network system will be the

hallmark of a vital aerospace industry in the future.

Therefore, the basic theme of this Conference is "Networking as a Strategic Tool." Tutorials and Conference presentations will explore the technology and methods involved in this rapidly changing field, which will benefit engineers, managers, and technicians with development or support responsibility in a number of networking arrangements. Future directions will be investigated from a global, as well as local, perspective.

CALENDAR

Monday, April 29

7:30 a.m.	Tutorial Registration
8:30 a.m. - Noon	Tutorials
Noon	Lunch
<i>(for morning or afternoon participants)</i>	
1:30 - 5:00 p.m.	Tutorials

Tuesday, April 30

7:00 a.m.	Registration
8:15 a.m.	Welcome & Introductions
8:30 a.m.	Plenary Speaker
9:30 a.m.	Break
9:45 a.m.	Session 1
10:45 a.m.	Break
11:00 a.m.	Session 2
11:45 a.m.	Lunch - Lunch Speaker
1:15 p.m.	Session 3
2:30 p.m.	Session 4
3:30 p.m.	Break
3:45 p.m.	Session 5
4:45 p.m.	Session 6
5:30 p.m.	Conclusion

STEERING COMMITTEE

General Chair

Glenn B. Freedman, University of Houston-Clear Lake

Session Co-Chairs

Dennis Adams, University of Houston

George Collins, University of Houston-Clear Lake

Steve Prejean, GeoControl Systems

Tutorial Chair

Russ Mertens, Computer Sciences Corporation

Administrative Chair

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Bill Dennis, IBM Corporation

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Pattie Vining, Registration, SEPEC

Mary Watson, SEPEC

Pat Williams, SEPEC

CONFERENCE

April 30, 1991

Registration
Welcome & Introductions

7:00 a.m.
8:15 a.m.

Plenary Speaker

Glenn B. Freedman
Associate Vice President, University of Houston-Clear Lake

8:30 a.m.

Networking Strategies at Johnson Space Center

John R. Garman
Deputy Director, Information Systems Directorate, NASA/Johnson Space Center

Break
Session 1

9:15 a.m.
9:30 a.m.

Networking Standards

Chair: George Collins, *University of Houston-Clear Lake*

Networking Standards

Mark Davies, *Digital Equipment Corporation*

Break
Session 2

10:30 a.m.
10:45 a.m.

Networking Tools

Chair: Russ Mertens, *Computer Sciences Corporation*

Using Netmaster to Manage IBM Networks

Guss Ginsburg, *Computer Sciences Corporation*

Performance Analysis of LAN Bridges & Routers

Ankur R. Hajare, *MITRE Corporation*

Lunch

11:45 a.m.

Networking and the Transformation of Work

Dr. Anthony Gorry
Information Technology Programs, Baylor College of Medicine

Session 3

1:15 p.m.

Systems for Group Support

Chair: Dennis Adams, *University of Houston*

Group Decision Support Systems

Don Petersen, *Collaborative Technology Corporation*

Computer Conferencing: Choices & Strategies

Jill Y. Smith, *University of Denver*

Session 4

2:30 p.m.

Network Applications

Chair: Steve Prejean, *GeoControl Systems*

Working with Cross-Functional Systems

Mark Lee, *VALIC*

Cooperative Processing Data Bases

Juzar Hasta, *Gupta Technologies Inc.*

Break
Session 5

3:30 p.m.
3:45 p.m.

Management Concerns in Networking

Chair: Dennis Adams, *University of Houston*

Information Logistics

Dennis Adams, *University of Houston*

The Business Case for Connectivity

Rudy Hirschheim, *University of Houston*

Session 6

4:45 p.m.

Network Editorial Panel

Moderator: Glenn Freedman, *University of Houston-Clear Lake*

Panelists from major computing publications will comment on conference topics.

Conference Conclusion

5:30 p.m.

Plenary Speaker

Networking Strategies at Johnson Space Center

John R. Garman

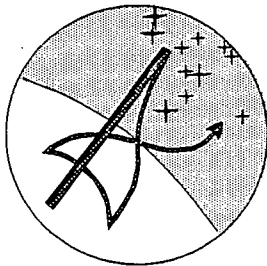
*Deputy Director, Information Systems Directorate,
NASA/Johnson Space Center*



Johnson Space Center

Information Systems Directorate

Networking at JSC



netstc00-jrg10421

presentation to
"Networking as a Strategic Tool"
Conference

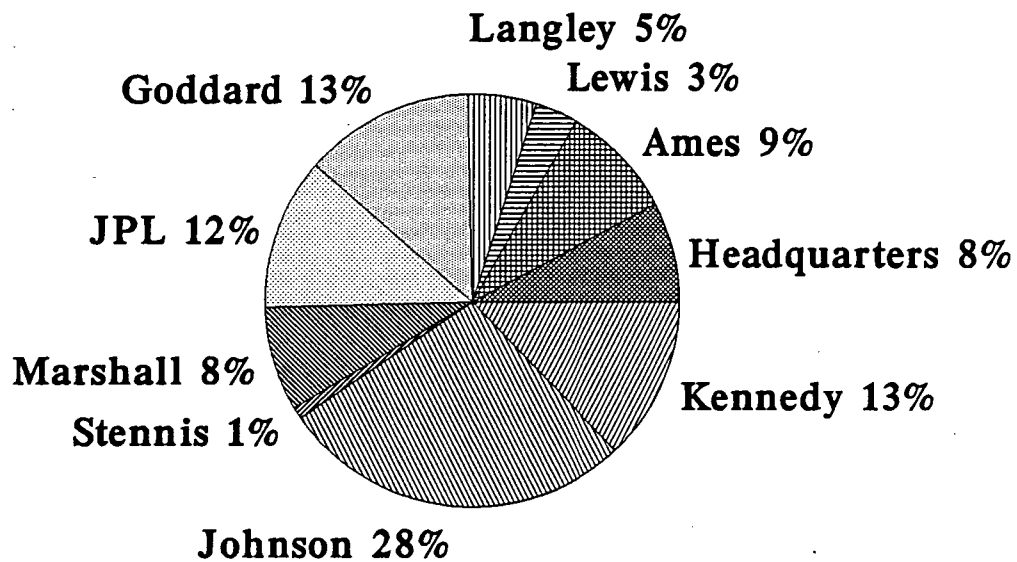
John R. Garman
April 30, 1991

Presentation Outline

- **JSC Network Perspectives**
- **IRM Approach at JSC**
- **The Information Systems Directorate**
- **Approach to JSC Networking Growth and Consolidation**

netstc01-jrg10421

NASA IRM Budget by Center

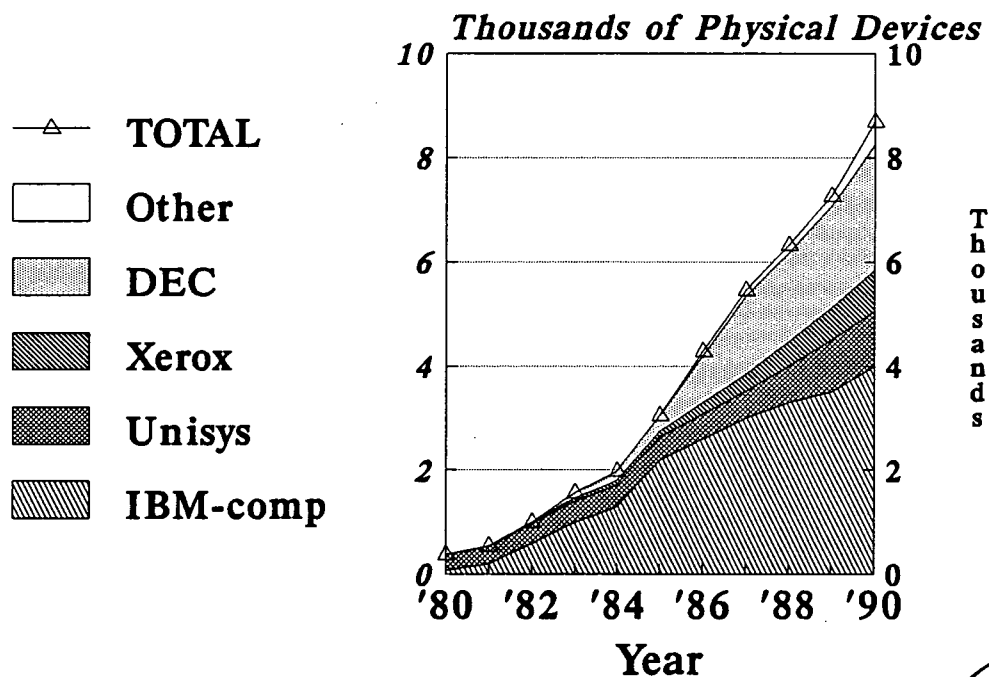


itap01-jrg10421

Source: GSA Report based on FY89 ITSP

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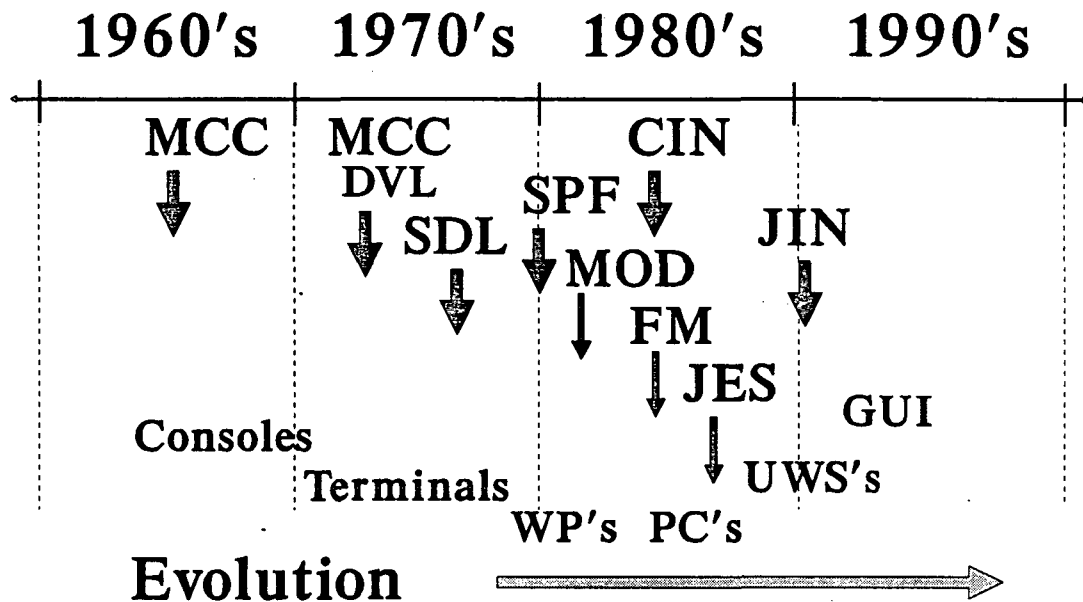
JSC Campus Networks



net01-jrg10417

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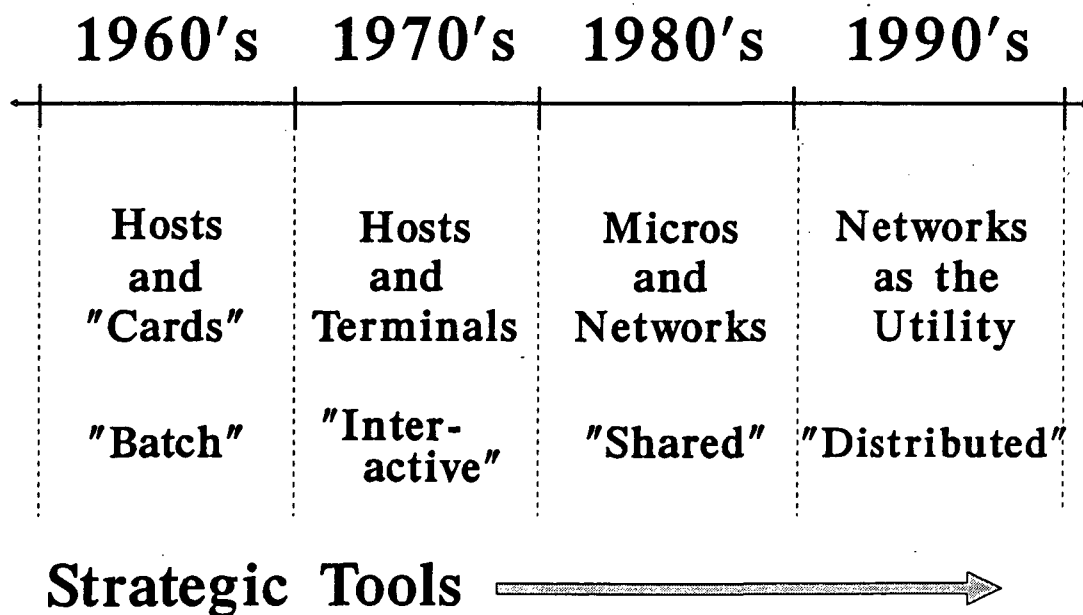
Networks Evolution at JSC



netatc06-jrg10421

5

Networking Evolution



netatc03-jrg10421

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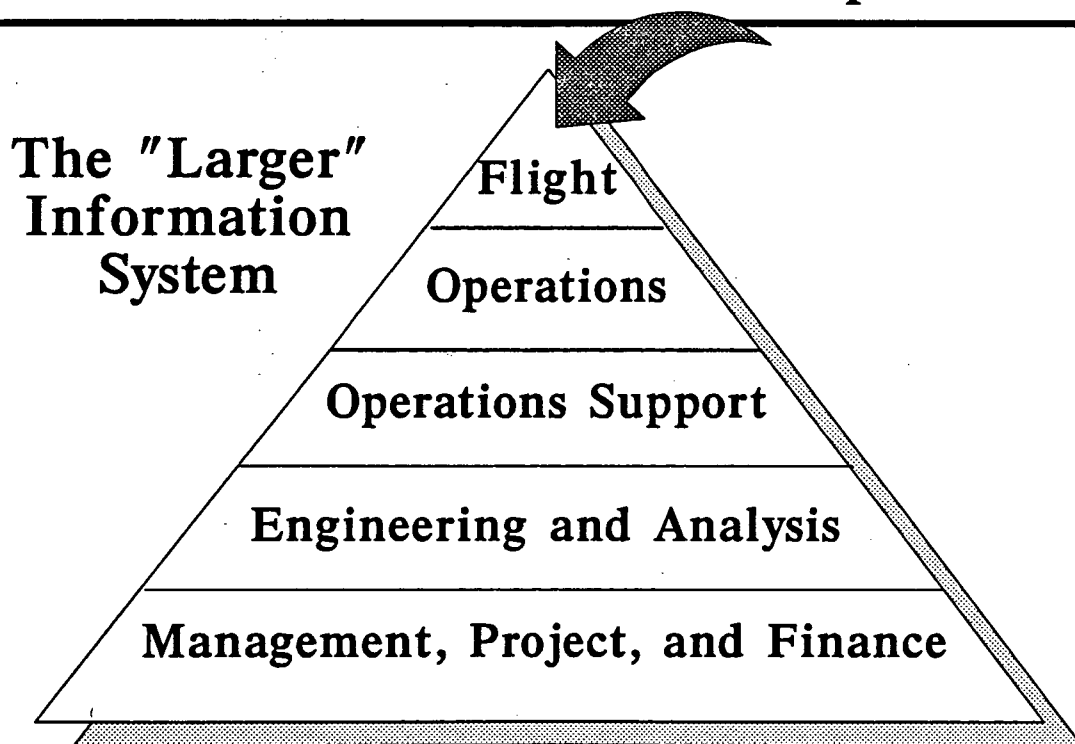
Networking as a Strategic Tool

- Since the 1960's, computing power has been shifting from centralized hosts to distributed environments
- Networks are a strategic tool for distributed computing platforms
- Strategic planning is necessary to insert the technology, and increase reliability and availability of networks

netatc02-jrg10417

7

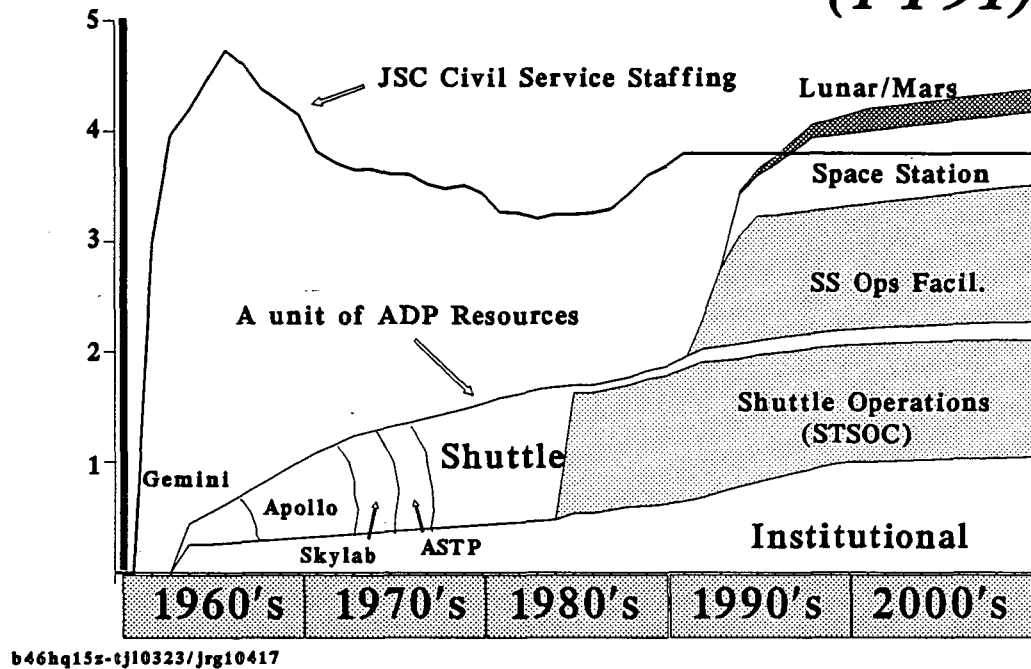
I/S Environment - "Mission" Perspective



rol05a-jrg10210

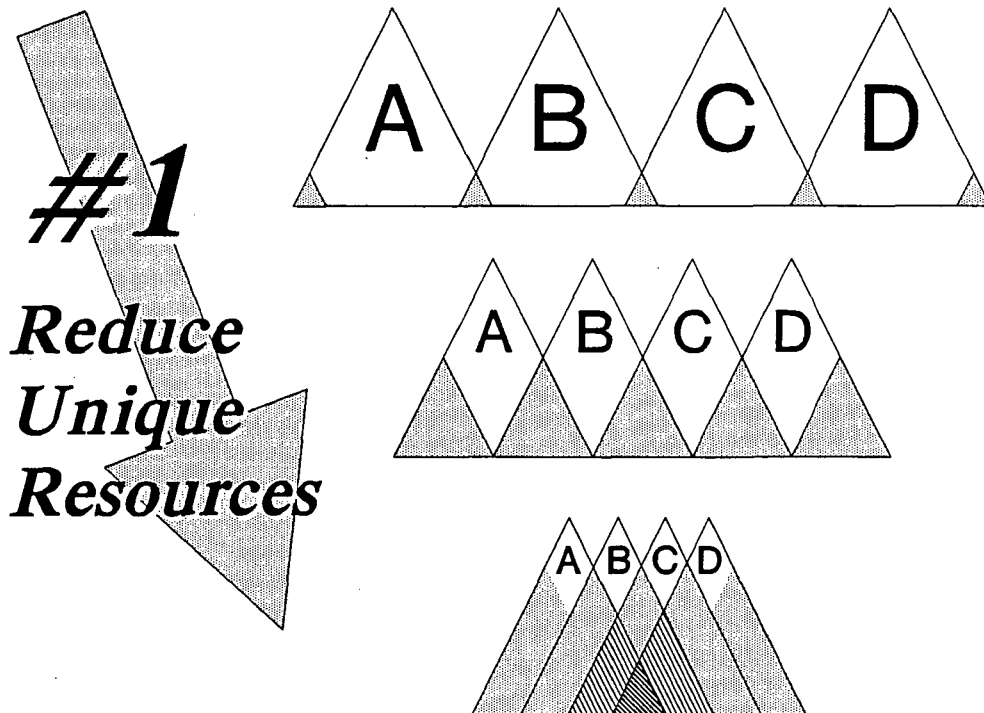
8

JSC ADP vs. Civil Service Staffing (FY91)



9

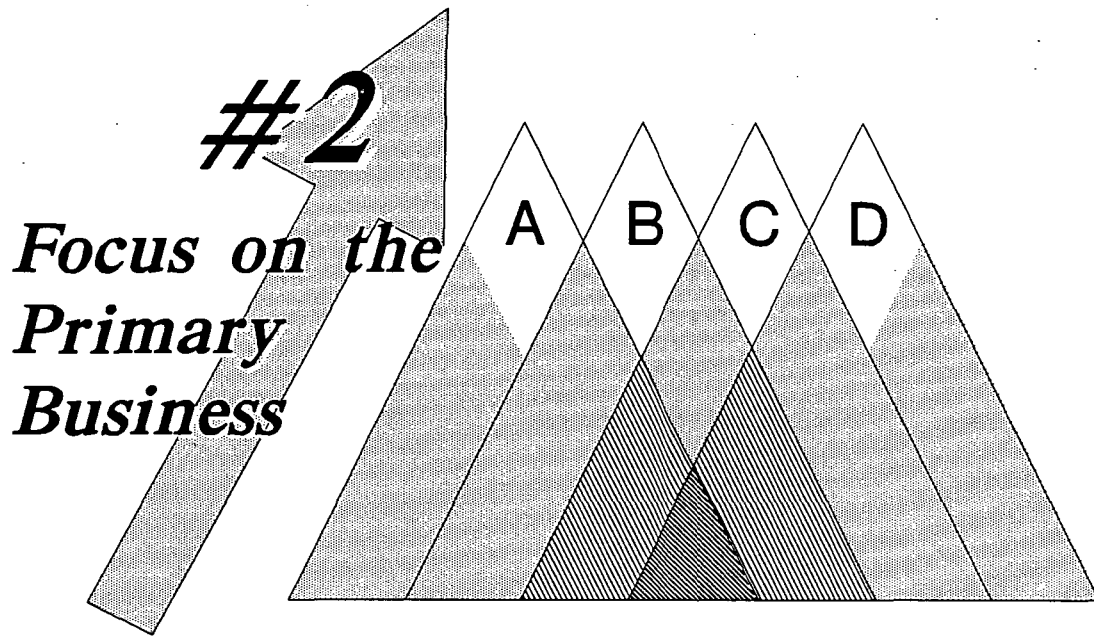
I/S Quality Approach - Efficiency



roi10-jrg10210

10

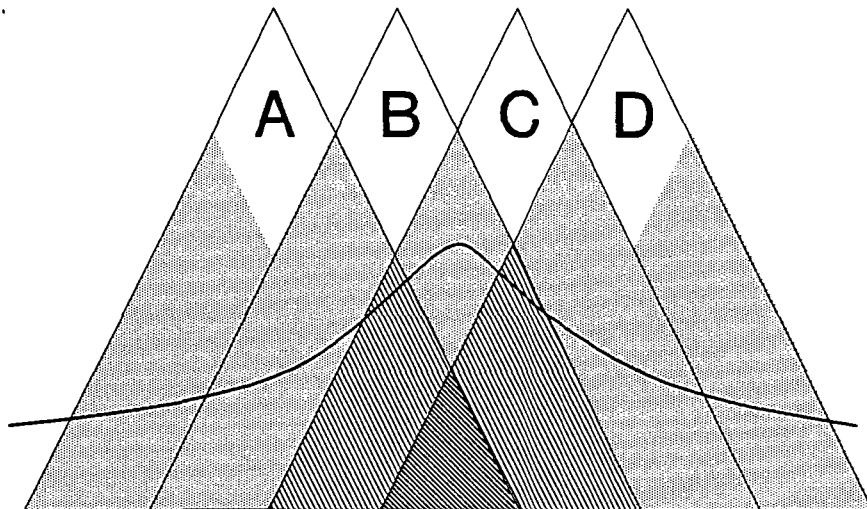
I/S Quality Approach - Focus



roi11-jrg10210

11

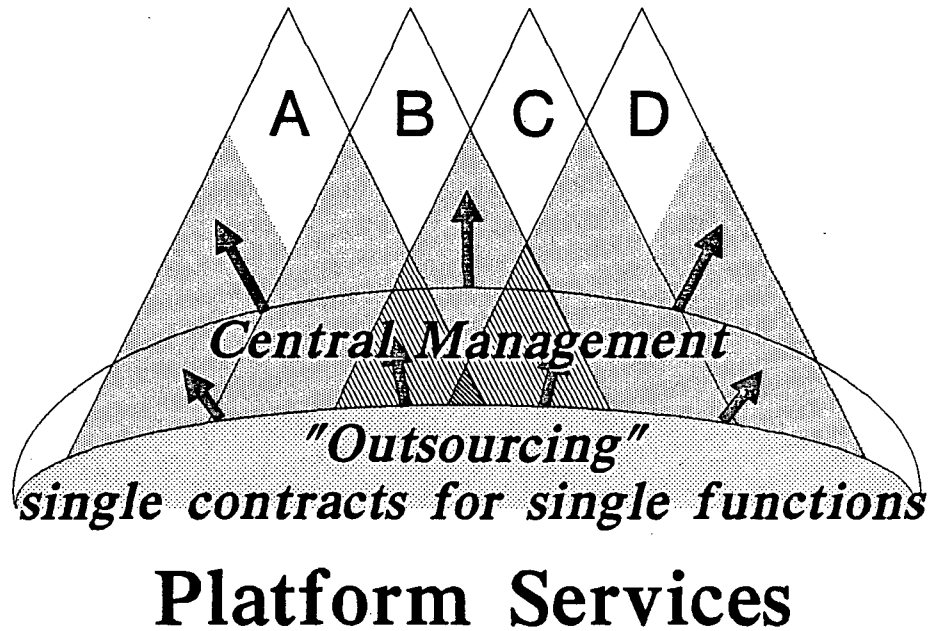
I/S Quality Approach - Commonality



roi11a-jrg10210

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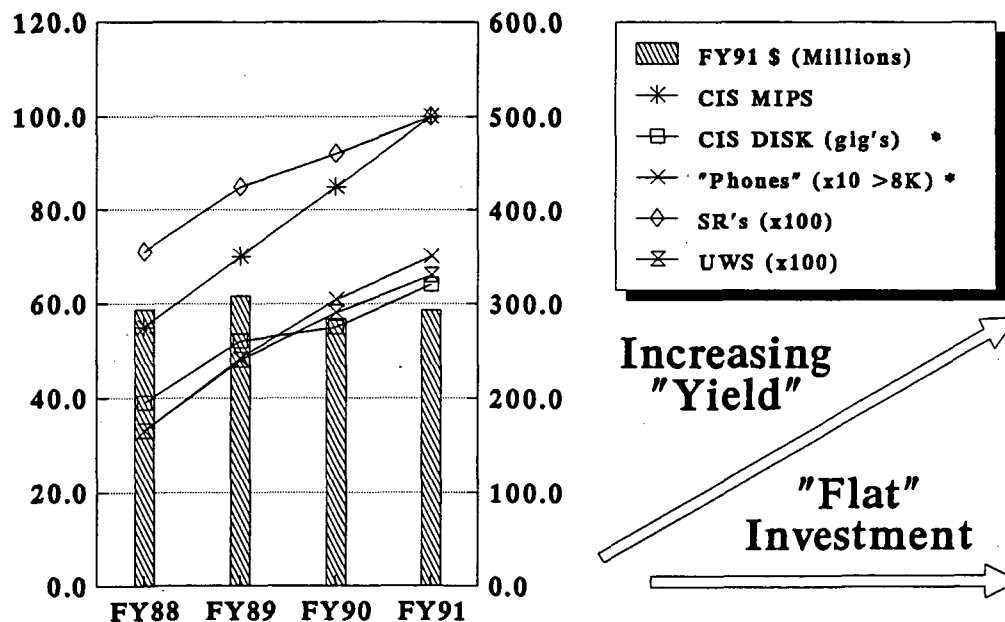
I/S Management/Contract Evolution



rol12-jrg10210

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ISD "Return-on-Investment"



rol02-jrg0417

Note: FY91 statistics are projections

14

Information Systems Directorate "Charter"

"ISD is established to lead and support the IRM Council in the establishment of Centerwide standards and policies for information services and to consolidate, in time, all institutional information services under a single JSC organizational structure".

Aaron Cohen

Director, Johnson Space Center

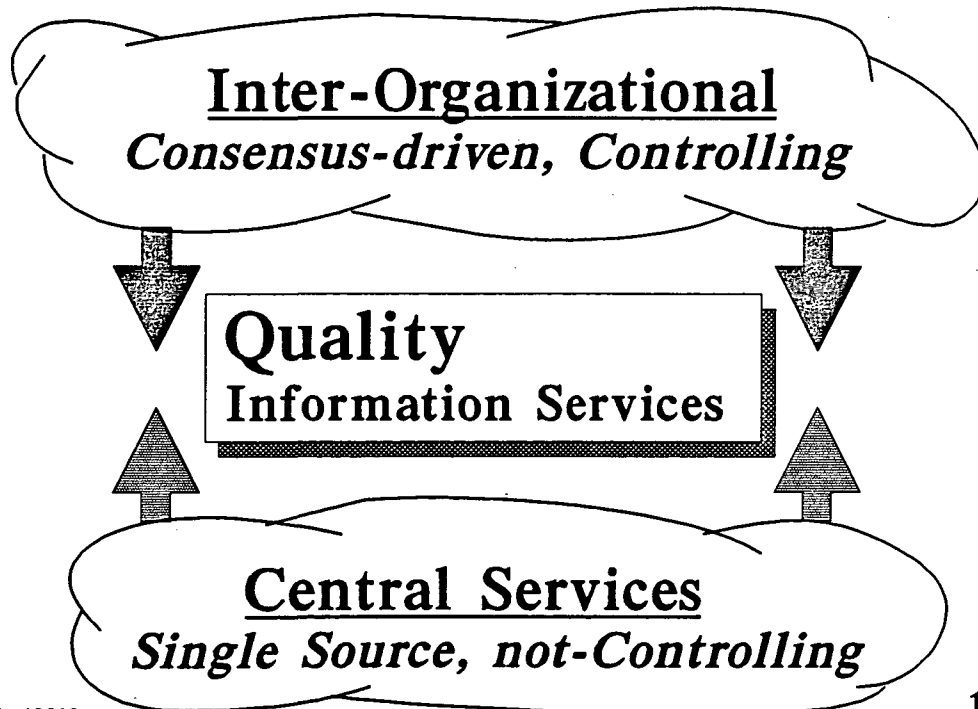
JSC Announcement 90-062

March 30, 1990

isd25-jrg10210

15

General IRM Approach for JSC



isd23f-jrg10210

16

JSC Networking Challenges

- Proliferation and Autonomy
- Rapid and continuing growth
- Acquisition Risks in Standards
- ADP security
 - unknown vulnerabilities
 - no ranked services
- Budget

jsep01a-0204jmc jrg10421

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JSC Network Requirements Functions

- Distributed Processing
- Growth
- Heterogeneous
- Security
- Management

netstc04-jrg10417

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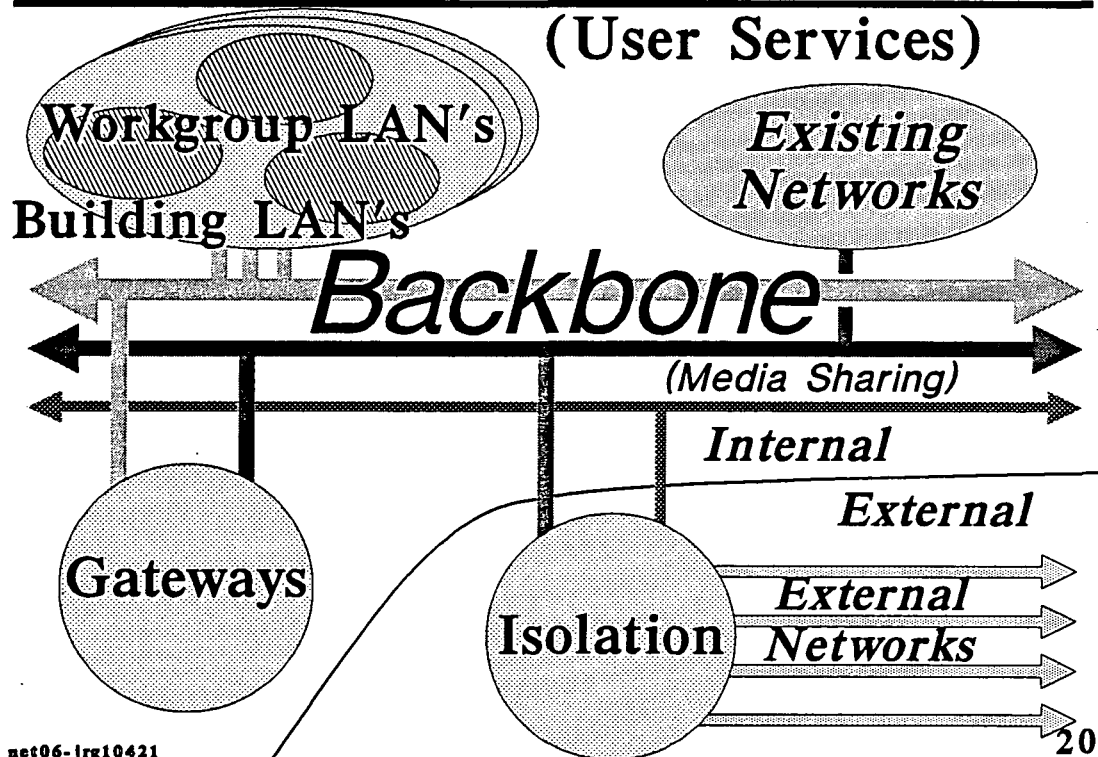
JSC Network Requirements Results

- A full range of network services on an institutional platform
- Open (authorized) access
- Focal point for outside interfaces
- Consolidation and integration of resources at JSC

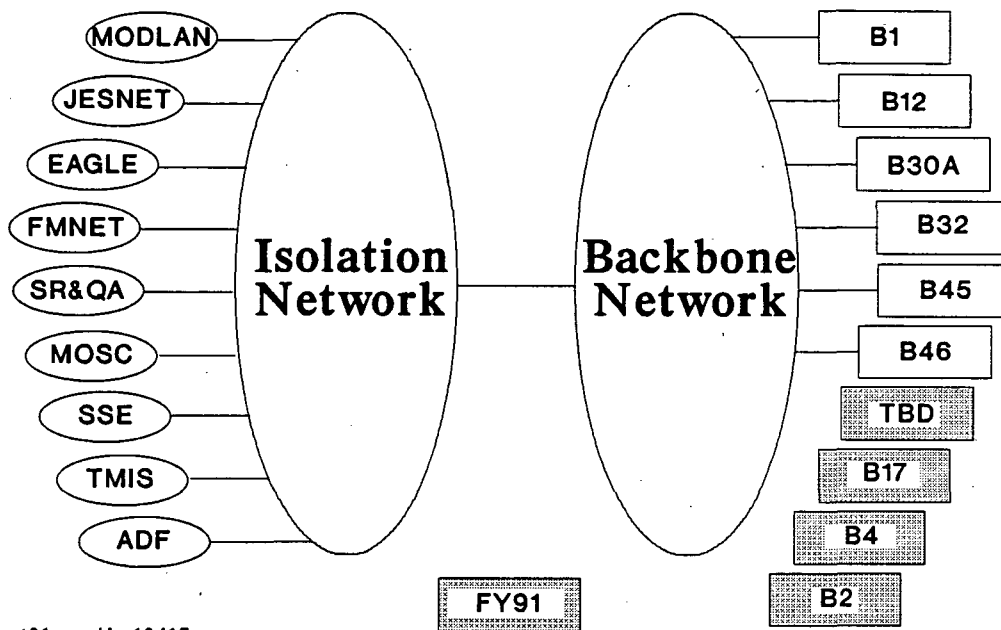
netstc08-jrg10421 jsnp03-0204jmc

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JSC Information Network



JSC Information Network Status



21

CONCLUSION

- Networks have evolved and proliferated rapidly in the industry
- JSC is undergoing fundamental changes (Multi-programs in particular)
- Networkings is the foundation of the next major evolution in I/T strategies (Consolidation via distributed processing)
- Network Technology isn't up to the task yet! (standards, products, speed)

The End

of the briefing.....

ecb98-jrg01021

Session 1

Networking Standards

Chair: George Collins, *University of Houston-Clear Lake*

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Networking Standards
Mark Davies, *Digital Equipment Corporation*

ABSTRACT

The enterprise network is currently a multivendor environment consisting of many defacto and proprietary standards. During the 1990s, these networks will evolve towards networks which are based on international standards in both the LAN and WAN space. Also, you can expect to see the higher level functions and applications begin the same transition.

The Open Network Advantage

Market Requirements

OPEN NETWORKS!!!

- **Multi-protocol, multi-platform, multi-vendor networks working together**
- **International AND defacto standards**
- **Effortless communications within and between enterprises**
- **Ability to move to standards at own pace**



What is an Open System?

Defined as:

A vendor-neutral computing environment:

- compliant with International and defacto standards**
- permits system and network interoperability or software applications portability**
- includes consistency of data and human access**
- satisfies one or more of a business's functional requirements**



Standards

Benefits from networks based on international and defacto standards

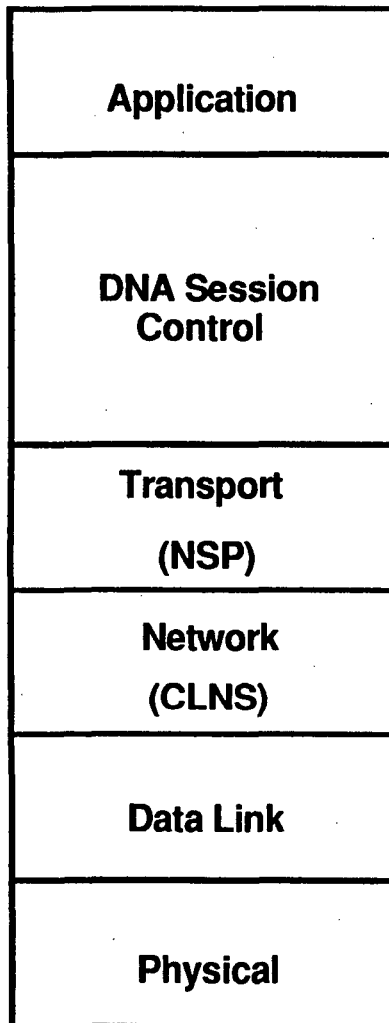
- o Vendor independence**
- o Applications portability**
- o Investment protection**
- o Improved communications leading to increased productivity**
- o Network flexibility**



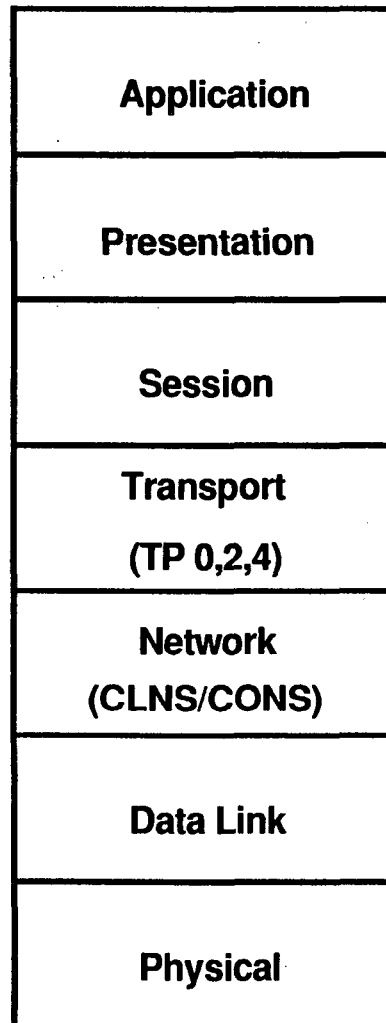
Network Architectures:

DECnet, OSI, TCP/IP

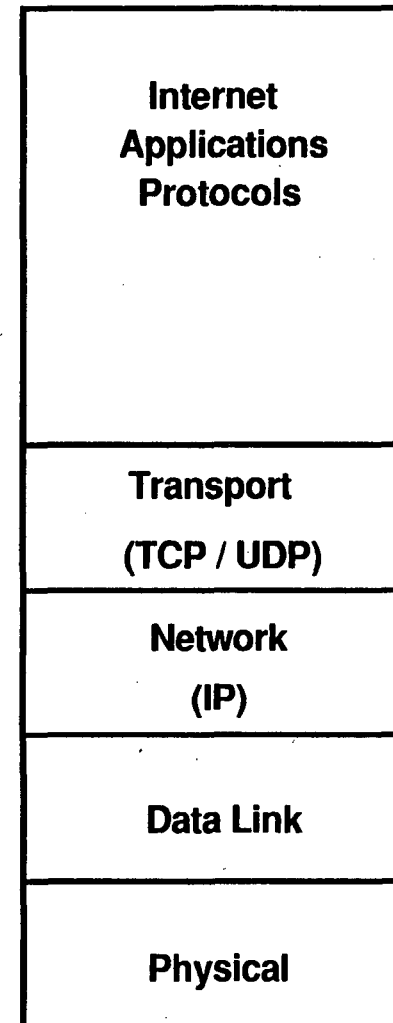
DECnet



OSI



IP



What is TCP/IP?

- o a.k.a. ----> The Internet Protocol Suite**
- o In use since late 1970s**
- o Developed for Advanced Research
Project Agency Network (ARPANET)**
- o Used to allow interaction of many private ARPA
subnetworks in government and research**
- o Inclusion with Berkeley UNIX
encouraged rapid growth**
- o Growth of UNIX-based workstations
and multivendor networking,
in lieu of OSI,
insures a long life for TCP/IP**

The Internet Protocols

- Physical/Datalink (Ethernet, X.25)
 - Network Layer
 - Internet Protocol (IP)
 - Internet Control Message Protocol (ICMP)
 - Address Resolution Protocol (ARP)
 - Internet Gateway
 - Transport Layer
 - Transmission Control Protocol (TCP)
 - User Datagram Protocol (UDP)
 - Applications Layer
 - Simple Mail Transfer Protocol (SMTP)
 - File Transfer Protocol (FTP)
 - Virtual Terminal (TELNET)
 - Network File System (NFS)
-

The Internet Protocols (TCP/IP)

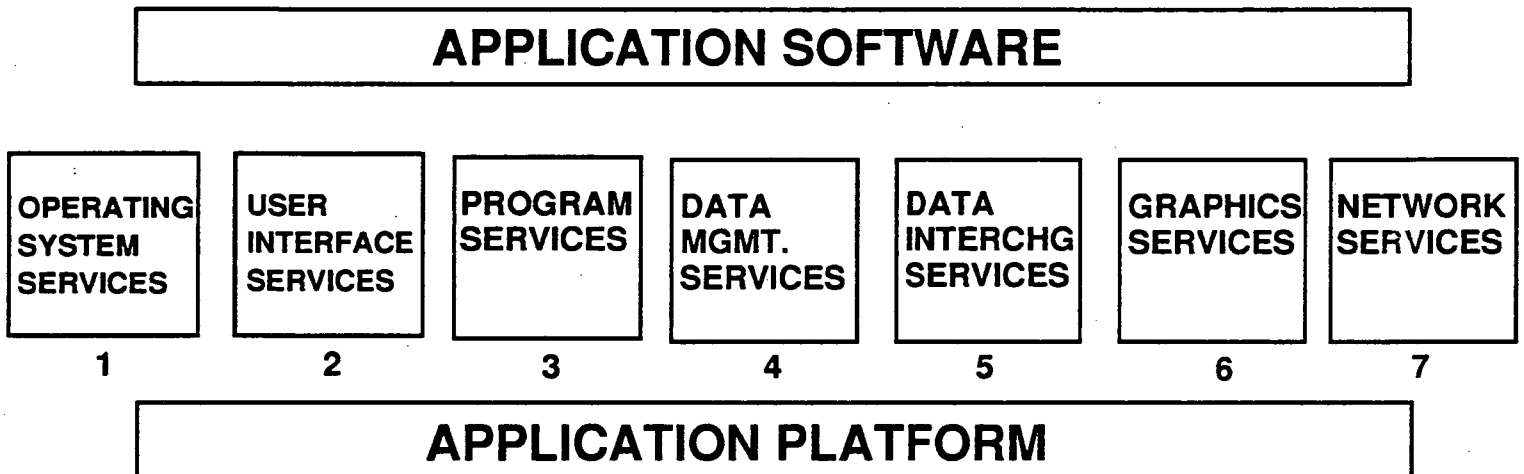
7 – Application	FTP	telnet	SMTP	r-Commands
6 – Presentation	XDR			
5– Session	RPC			
4 – Transport	TCP			UDP
3 – Network	IP			
2 – Data Link	Ethernet / Point-to-Point			
1 – Physical	Ethernet / Point-to-Point			

What is OSI?

- o Emerging technology**
- o a.k.a. ----> Open Systems Interconnection**
- o A layered network architecture
based on a seven-layer model**
- o Developed by the International Organization
for Standardization (ISO)**
- o OSI defines the standards for communications
between open systems on a global scale**
- o Supported by governments and major computer
vendors (Digital, IBM, HP,
Sun, UNISYS, Siemens, etc)**
- o Required by Government OSI Profiles (GOSIP)**
- o Foundation for global addressing and
new distributed applications (EDI)**

GOSIP in the Open Systems Environment

Elements of a standards based "Open System" :



1. POSIX.1, POSIX.2, GNMP, POSIX.6
2. FIPS 158 - X Window System
3. Ada, C, COBOL, FORTRAN, PASCAL, PCTE+, SCCS
4. IRDS (Data Dict/Dir Component), SQL, RDA
5. ODA/ODIF, SGML, CGM, IGES, STEP
6. GKS, PHIGS
7. FIPS 146 - GOSIP

U.S. GOSIP STANDARDS BASED APPLICATIONS

SERVICES OFFERED:

CORPORATE MESSAGING

FILE TRANSFER

VIRTUAL TERMINALS

USER INTERFACES

DIRECTORY SERVICES

TRANSACTION PROCESSING

REMOTE PROCEDURE CALLS

APPLICATION PORTABILITY

INTER-NETWORK

LOCAL AREA NETWORK

OFFICE AUTOMATION

CIM

STANDARDS:

X.400/EDI

FTAM

VTP

X WINDOWS/MOTIF

X.500

ISO TP

RPC

X/OPEN

ISO IS - IS (DP 10584)
ISO ES - IS (ISO 9542)

ISO 8802

ODA/ODIF

MMS/MAP

U.S. GOSIP Standards Based System Elements

APPLICATION LAYER

7

MHS X.400	FTAM ISO 8571	ODA	VTP ISO 9041	EDI ANSI X.12	MHS 1988	X.500 ISO 9594	NET MGT
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PRESENTATION LAYER

6

ISO 8823

SESSION LAYER

5

ISO 8327

TRANSPORT LAYER

4

TRANSPORT CLASS 4 ISO 8073	TRANSPORT CLASS 0 ISO 8073	CONNECTIONLESS ISO 8602
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NETWORK LAYER

3

CLNP ISO 8473	SNDCP DP 10584	X.25 PLP ISO 8208	CONS ISO 8348	ISDN Q.931	ES-IS ISO 9542	IS-IS DP 10584
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DATA LINK LAYER

2

802.2, LLC TYPE 1 CLASS 1 ISO 8802/2	HDLC LAPB ISO 7776	ISDN LAPD Q.921
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PHYSICAL LAYER

1

802.3	802.4	802.5	RS-232 V.35	ISDN	FDDI
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U.S. GOSIP Version 1.0

Requirements Summary:

- Issued January 1989 as FIPS-146
- Mandatory in RFPs as of August 1990
- FTAM- Phase 2
 - Limited Purpose
 - T1 Simple File Transfer
 - M1 Management
 - Full Purpose
 - T2 Positional File Access
 - A1 Simple File Access
 - M1 Management
- Initiator/responder, Sender/Receiver
- Transport Protocol Class, Connectionless Network Service
- MHS
 - CCITT X.400 MHS 1984
 - P1, P2
 - TP 0, CONS, X.25 or TP4, CLNS

U.S. GOSIP Version 2.0

Requirements Summary:

- Issued March 1991 Revision to FIPS 146
- Mandatory in RFPs as of October 1992
- FTAM Phase 2
 - Full Purpose
 - T1,T2 Simple, Positional File Access
 - A1 Simple File Access
 - M1 Management
 - FTAM 1,2,3 Document Types
 - Initiator/Responder, Sender/Receiver
- VTP
 - Telnet
 - Forms (optional)
 - TP4, CLNS
- MHS
 - CCITT X.400 MHS 1984
 - P1,P2
 - TP 0, CONS, X.25 or TP4, CLNS
- Office Document Architecture

Summary Protocols

OSI Model	Internet	DECnet	OSI
Application	FTP TELNET SMTP	DAP CTERM MAIL11	FTAM VTP X.400
Presentation			
Session			
Transport	TCP UDP	NSP —	TP4 TP0, CLTS
Network	IP ICMP, ARP	Routing Routing	CLNP, IP ISIS
Data Link	Ethernet		
Physical			

Coexistence and Transition Techniques

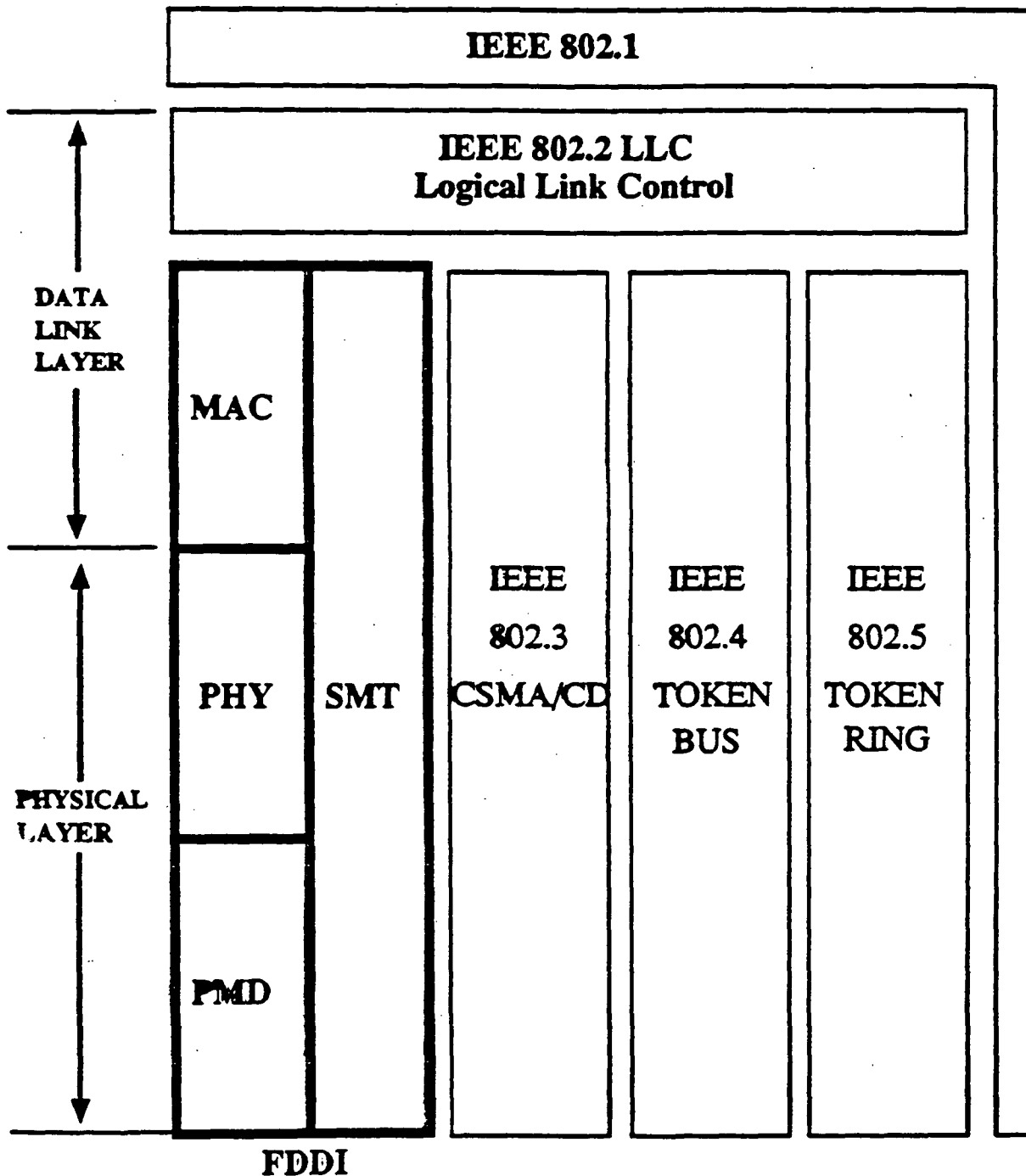
Protocol Based:

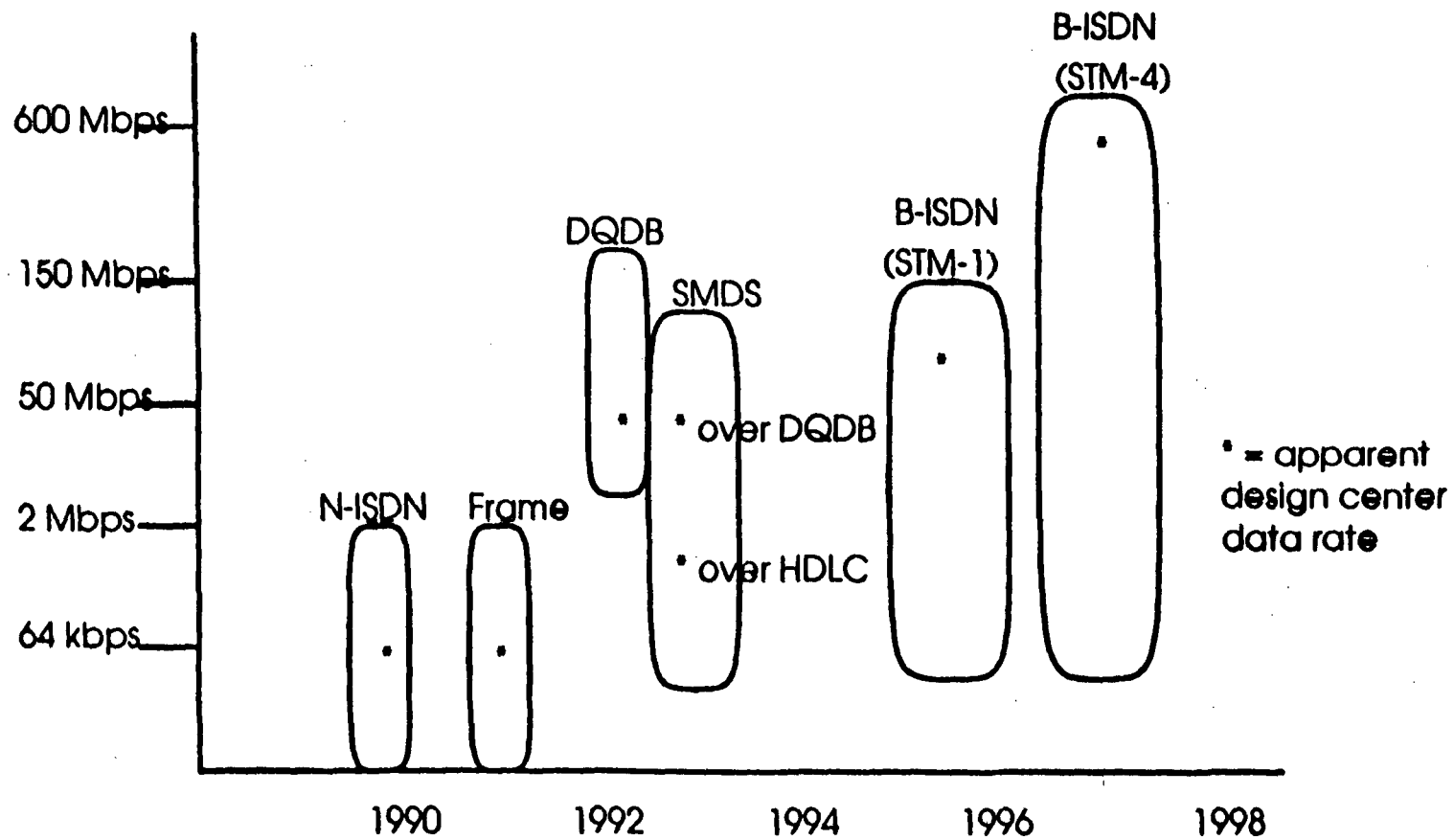
- o Dual Stacks**
- o Hybrid Stacks**
- o Transport Gateway**
- o Applications Gateways**
- o Transport Layer Interfaces**
- o Multi-Protocol Routers**

Service Based:

- o Transport Service Bridge**
- o Portals or Tunnels**

FDDI and OTHER LAN STANDARDS





Estimated time frames for commercial introduction of new public network services



DECnet / OSI Phase V

What is DECnet / OSI Phase V?



DECnet / OSI Phase V

- o Next Generation Networking Environment for the 1990s**
- o Based on 15 years of DECnet experience in peer to peer networking**
- o One framework for Small to Large Heterogeneous Networks**
- o Set of Common Network Services and Applications across Digital and industry standard operating environments**
- o Base for Key Layered Services**



What is Digital Doing?

- o Integration**
- o Products**

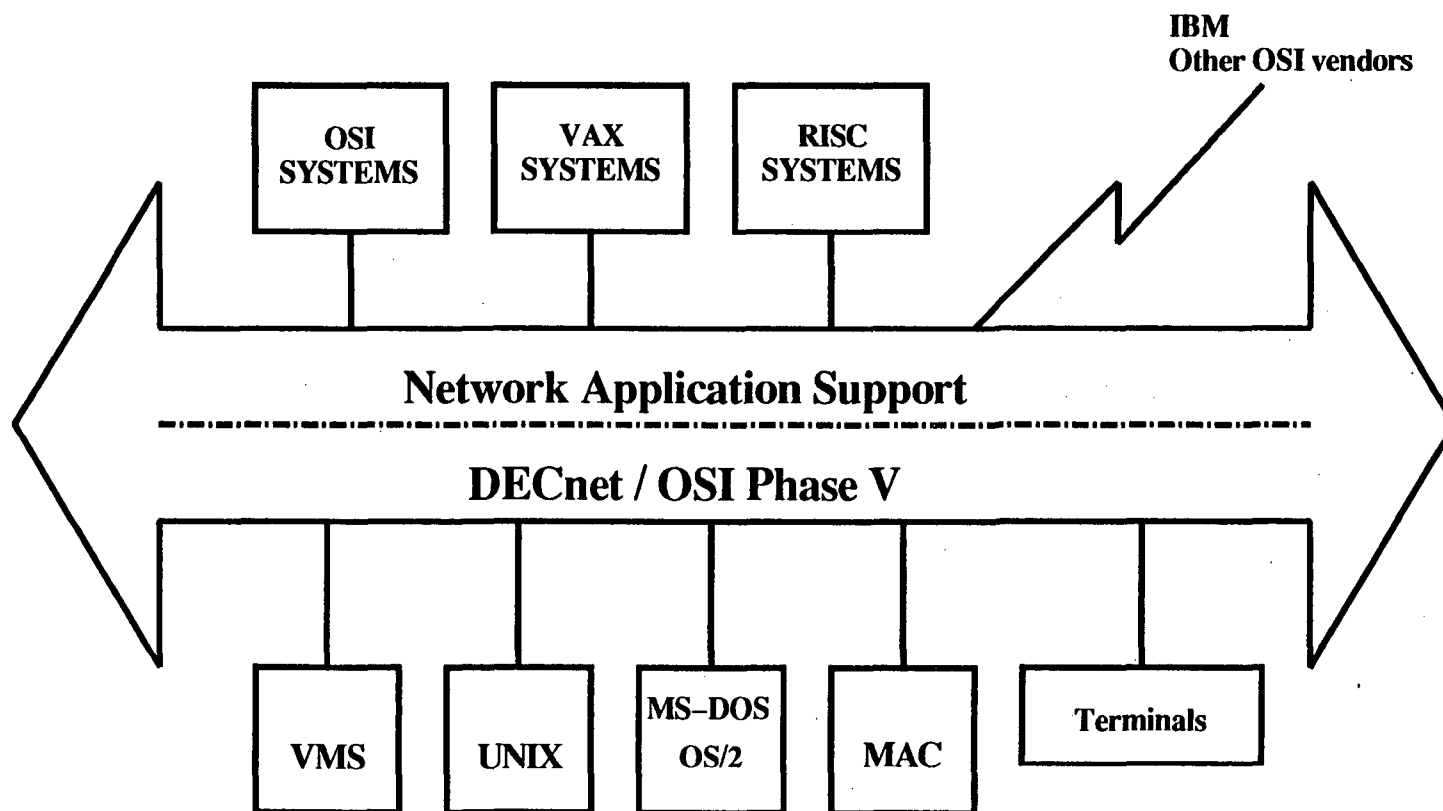


Integration

- o Provide coexistence of standard and proprietary protocols**
- o Provide transparency of OSI and TCP/IP network to the user**
- o Expand network address size in anticipation of global OSI networks**
- o Enhance network management capabilities based on network management standards**

DECnet / OSI Phase V

Foundation for Network Application Support





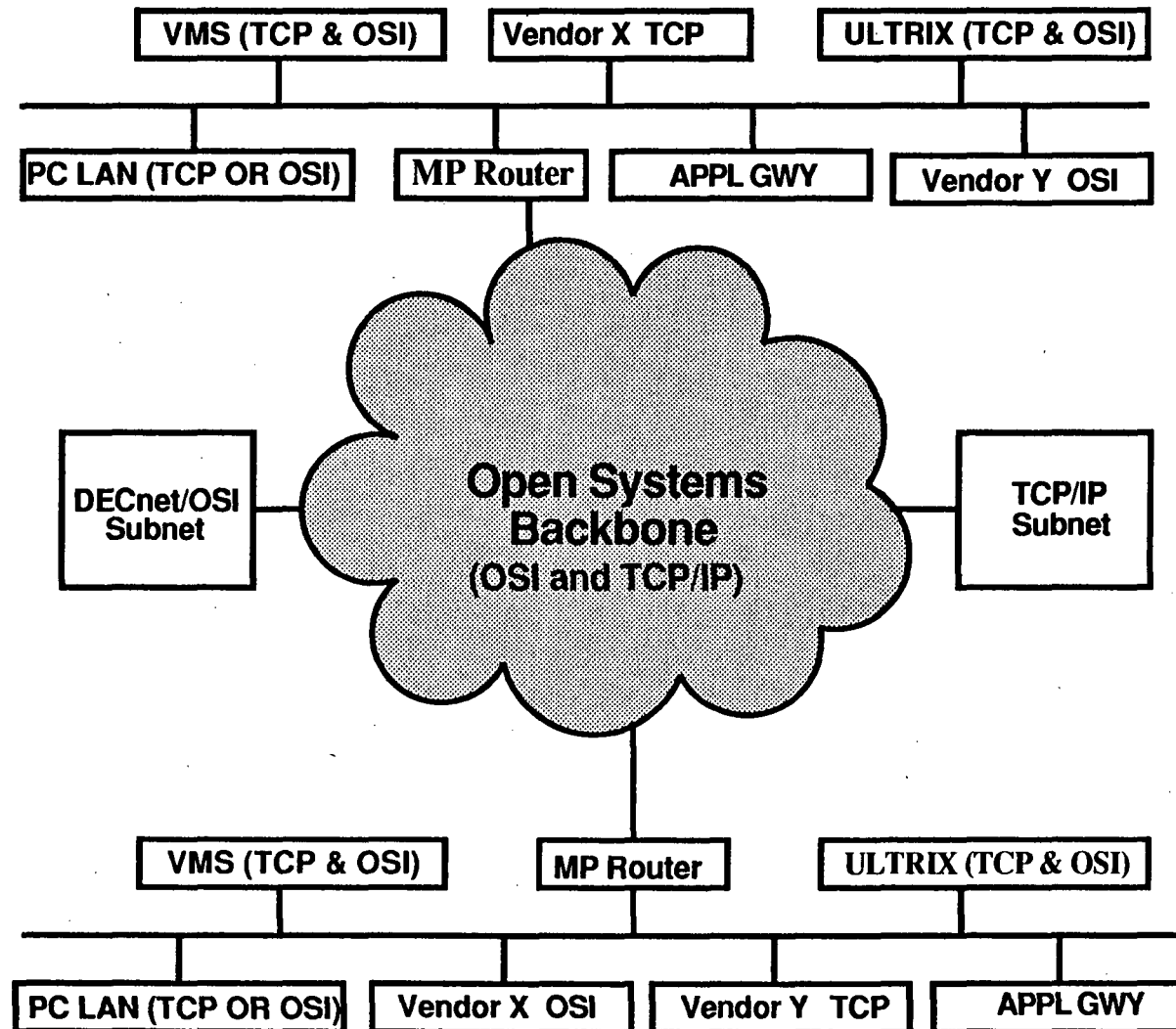
DECnet / OSI: Foundation for Network Application Services

Services offered:

Products:

Windowing Services	DECwindows, X Windows / Motif
Messaging Services	MAILbusTM Family, EDI, X.400
Data Access Services	SQL/Services, RDB, DBMS, VIDA for DB2, FTAM
Terminal Services	LAT, TELNET, CTERM, VTP
Directory Services	DECdns, X.500
Office Automation	All-IN-1TM Phase II, CDA VAX Notes, VTX
Forms	DECforms
Transaction Processing	DECtp
SNA Connectivity	DECnet/SNA Products

Open Systems Networking



Session 2

NetworkingTools

Chair: Russ Mertens, *Computer Sciences Corporation*

N92-12500

Using NetMaster To Manage IBM Networks
Guss Ginsburg, *Computer Sciences Corporation*

Abstract

After defining a network and conveying its importance to support the activities at the Johnson Space Center, the presenter demonstrates the need for network management based on the size and complexity of the IBM SNA network at JSC. Network Management consists of being aware of component status and the ability to control resources to meet the availability and service needs of users. The presenter addresses the concerns of the user as well as those of the staff responsible for managing the network. He explains how NetMaster (a network management system for managing SNA networks) is used to enhance reliability and maximize service to SNA network users through automated procedures. He discusses customization, problem and configuration management, and system measurement applications of NetMaster.

The presenter gives several examples that demonstrate NetMaster's ability to manage and control the network, integrate various product functions, as well as provide useful management information.

NETWORKING AS A STRATEGIC TOOL

**USING NETMASTER TO
MANAGE IBM SNA NETWORKS**



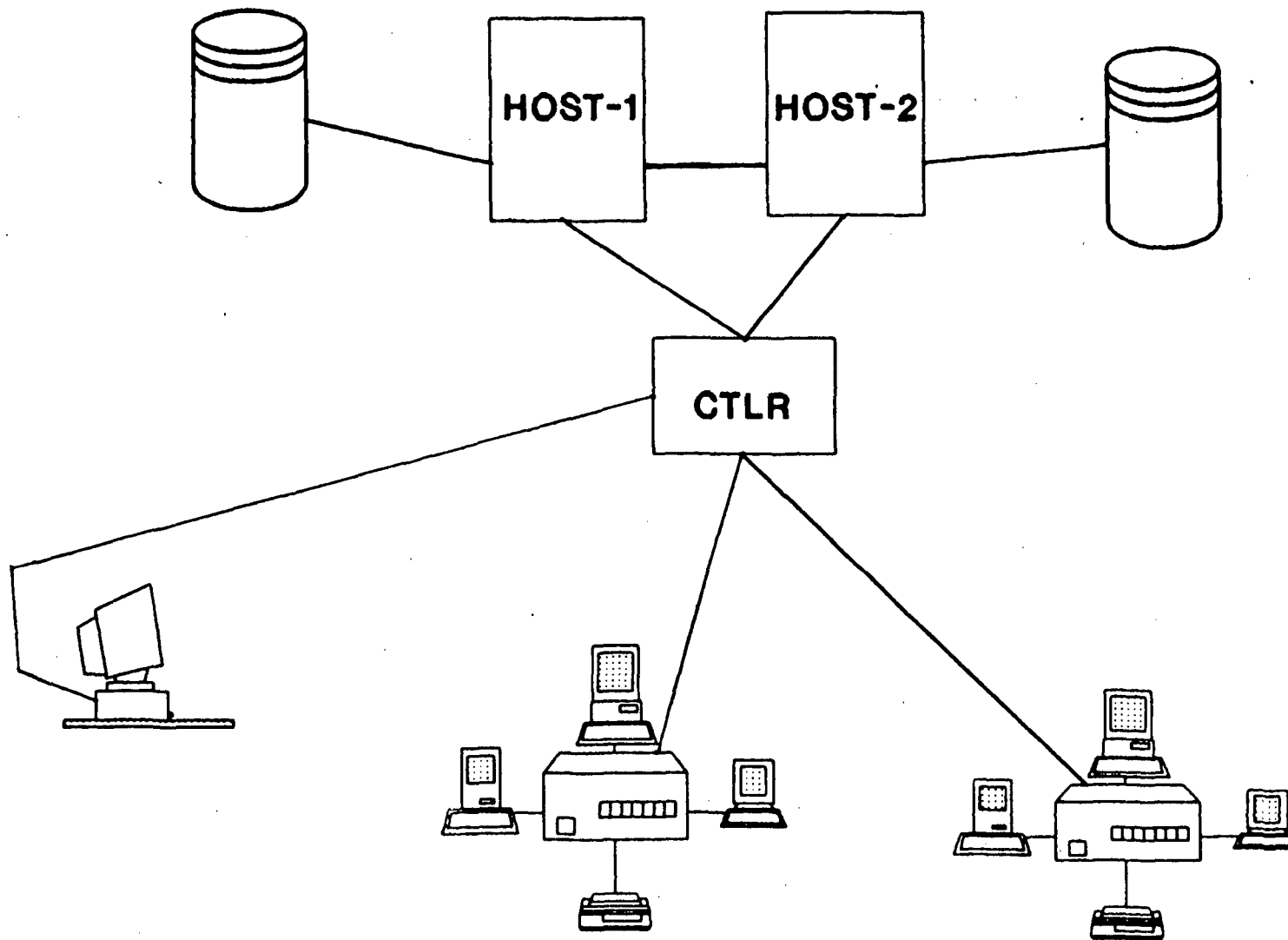
Guss Ginsburg
April 1991

OVERVIEW

- **Definition of a Network**
- **Rationale and Objectives of Network Management**
- **How NetMaster Fits into the Picture**
- **NetMaster Features used at JSC**
- **Summary**

DEFINITION OF A NETWORK

**A System of Computers, Terminals, and Data
Connected by Communication Lines**



NETWORKS ARE VITAL TO THE ENTERPRISE

- **Mission Success Depends on Network Availability**
- **Downtime is Expensive**
 - **Lost Revenues and Opportunities**
 - **Projects can be Delayed**

WHY MANAGE A NETWORK?

- **Critical Resource**
- **Maintain Reliability**
- **Maximize Service**

NETWORK MANAGEMENT CONSISTS OF ...

- **Component Status Awareness**
- **Controlling Network Resources to meet ...**
 - **Availability Goals**
 - **Service Requirements**

CONCERNS

CUSTOMERS/USERS

- **Availability**
- **Response Time**

NW & SYSTEMS MANAGEMENT

- **Customization Efforts**
- **Automated Recovery**
- **Minimize User-Reported Problems**
- **Problem Management**
- **Configuration Management**
- **Measurement Tools**

NETMASTER

- **Selected by Competitive Procurement
Based on Ability to Address our Concerns**
- **Provides an Operating Environment Conducive to
Monitoring and Controlling our Network**

NETMASTER

AUTOMATED RECOVERY PROCEDURES

- **Message-Driven**
- **High-Level Language Interface (NCL)**
- **Panel Interface**
- **Can be Integrated with other NetMaster Components**

NETMASTER

AUTOMATED RECOVERY PROCEDURES (cont)

- **Reacts to Messages about Network Events**
- **Automatically Attempts to Recover from Outages**
- **Alerts the Network Control Center**
- **Avoids Screen Clutter by Filtering Messages**

NETMASTER

CUSTOMIZATION

- **Parameters Specified at Installation**
- **Minimal Exit Coding**
- **NCL Procedures Can be Modified by Analyst Staff**
- **Rules-based Systems**

NETMASTER

PROBLEM MANAGEMENT

- **Records Events by Resource**
- **Available for Review and Reporting**
- **Facilitates Trend Monitoring**
- **Indicates Deteriorating Conditions
Before User is Aware of Problem**
- **Can be Integrated with other Components**

NETMASTER

CONFIGURATION MANAGEMENT

- **Derived From Network Definitions**
- **Database Accurately Reflects Configuration**
- **Can be Augmented with User-Defined Data**
- **Can be Integrated with Problem Management and Other Functions**

NETMASTER

MEASUREMENT TOOLS

- **Response-Time Monitor**
- **Availability**

SUMMARY

NETMASTER

- **Helps Monitor and Control our SNA Network**
- **Provides Management Information**
- **Uses Automation and Rules-based Systems**

N92-12501

Performance Analysis of LAN Bridges & Routers

Ankur R. Hajare, *MITRE Corporation*

Abstract

Bridges and routers are used to interconnect Local Area Networks (LANs). The performance of these devices is important since they can become bottlenecks in large multi-segment networks. Performance metrics and a test methodology for bridges and routers have not been standardized. Performance data reported by vendors is not applicable to the actual scenarios encountered in an operational network. However, vendor-provided data can be used to calibrate models of bridges and routers that, along with other models, yield performance data for a network. Several tools are available for modelling bridges and routers, and Network II.5® was used for this study. The results of the analysis of some bridges and routers are presented in this paper.

PERFORMANCE ANALYSIS OF LAN BRIDGES AND ROUTERS

ABSTRACT

Bridges and routers are used to interconnect Local Area Networks (LANs). The performance of these devices is important since they can become bottlenecks in large multi-segment networks. Performance metrics and a test methodology for bridges and routers have not been standardized. Performance data reported by vendors is not applicable to the actual scenarios encountered in an operational network. However, vendor-provided data can be used to calibrate models of bridges and routers that, along with other models, yield performance data for a network. Several tools are available for modelling bridges and routers, and Network II.5® was used for this study. The results of the analysis of some bridges and routers are presented in this paper.

INTRODUCTION

Bridges and routers are used to interconnect multiple segments of a Local Area Network (LAN). These devices reduce congestion on a LAN since they restrict traffic that is local to a segment while forwarding only those packets that are addressed to devices on other segments [Reddy, 1990]. As shown in figure 1, bridges operate at the Data Link layer, which is layer 2 of the 7-layer Open System Interconnection (OSI) model. A bridge examines the destination address field of all valid packets on a LAN segment and, using an address table for each segment, determines whether the packet needs to be forwarded [Backes, 1988]. A few years ago, bridges required explicit programming of their address tables before installation. Today almost all bridges are learning bridges, i.e. they generate their address table by themselves when installed in a network. Although a learning bridge is much easier to set up and manage, this convenience is achieved at the expense of performance.

As shown in figure 1, routers operate at the Network layer, which is layer 3 of the 7-layer OSI model. Thus, routers are specific to a protocol such as TCP/IP, DECnet or Novell IPX. Until about a year ago, routers could handle only a single protocol. However, vendors have recently introduced routers that can handle multiple protocols, even when they are intermixed. Routers examine the source and destination addresses and, in some cases, routing information within each packet. Since this information is regarded as data by the data link layer

protocol, routers are insensitive to the layer 2 protocol that is being used. Routing imposes a larger computational burden on a device than bridging. Because of this, routers have performed slower than bridges. A performance ratio as high as 5:1 for bridging vs. routing has been reported [Spiner, 1990].

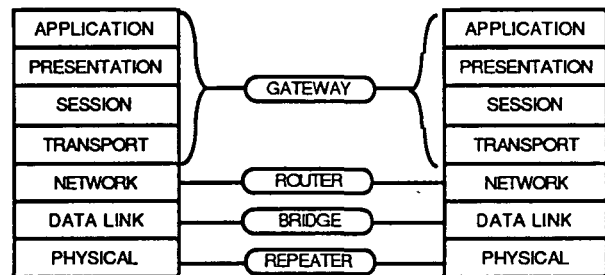


Figure 1: OSI Model Showing Repeaters, Bridges, Routers and Gateways.

Under certain circumstances, bridges and routers can become bottlenecks [Salwen et al, 1988]. Loss of packets by bridges and routers results in error conditions and re-transmission [Hordeski, 1987], which deteriorates end-user response times. Hence, it is important to measure and analyze bridge performance under various conditions that are encountered in an operational network [Rickert, 1990].

Most LAN performance studies focus on single segment performance [DuBois, 1988]. However, when end-to-end performance of a network is being assessed, bridge and router performance can be more important than the performance of the transmission medium [Boggs et al, 1988].

RATIONALE FOR MODELLING

Vendors of bridges and routers provide performance specifications for their products. Since no standards presently exist for the specification of bridge and router performance [Jackson, 1989 and Salamone, 1990], different metrics are reported by different vendors. Information about the conditions under which the performance data was derived is generally not provided by vendors. Since the testing methodology is not standardized either, each vendor can create tests that demonstrate their own products to be superior [Bradner, 1991].

Although test results are available from several sources, the data provided is not directly applicable to a real situation. That is because the tests are performed under conditions that are not typical of what is encountered in actual network usage. Usually, tests are performed with all packets of one size that arrive at a steady rate. Consequently, the effect of differences in buffer sizes is not demonstrated. In contrast, LAN traffic in the real world is bursty and buffer size does affect performance. Furthermore, most reported measurements are performed for uni-directional forwarding of all packets in a single stream with no other traffic on the LAN. Such test results, though not directly usable, can be used to calibrate performance models of bridges and routers. The model can then predict performance for bursty, multiple data streams that contain a random mix of packets of various sizes.

Full scale testing of bridges and routers for a comprehensive set of scenarios is not practical because of the large amount of test equipment and effort that would be required [Bradner, 1991]. Therefore, modelling is a practical alternative to assessing end-to-end performance of a large multi-segment network.

The performance models described in this paper were part of an effort to build a discrete event simulation model of a campus wide multi-vendor, multi-protocol network planned at the NASA Johnson Space Center (JSC). As a part of the task of modelling this network, models of all the types of devices within the network were being considered. The data from some of them are presented here.

MODELLING TOOLS

Performance models are either analytic models or simulation models. Several analytic models have been developed for single segment LANs [Stallings, 1987 and Boggs et al, 1988]. However, no adequate analytic models have been reported for inter-networking devices. Analytic models are based on assumptions that convert a real-world problem into one that is amenable to a closed-form solution. Simulation models, on the other hand, do not require such drastic or extensive assumptions.

Analytic models usually predict only steady-state conditions, whereas simulation models demonstrate the effects of transients and the effects of initialization. For example, a typical learning bridge rebuilds the address table every few minutes. Such transient conditions are best studied by means of a simulation model. Other transient conditions

amenable to simulation modelling include broadcast packets creating a broadcast storm.

Simulation models can be developed using either a general purpose simulation language (such as GPSS or Simscript®) or a network modelling tool. General purpose simulation languages provide more flexibility and power but are harder to use. Network modelling tools enable quicker development of models but are relatively restricted in their capabilities. Examples of network modelling tools are Network II.5®, Lannet II.5®, Block Oriented Network Simulator™ (BONeS™), and LANSIM™. In addition to these commercially available tools, several large organizations, such as IBM and AT&T, have their own modelling tools for in-house use [Van Norman, 1988].

The tool used for this study was Network II.5®, which is marketed by CACI Products, Inc. of La Jolla, California. This tool is installed on an IBM compatible mainframe at JSC and is accessible by the user community via the Center Information Network (CIN). This study does not imply an endorsement of the tool by NASA or by MITRE.

Network II.5® builds a discrete event simulation model from a model definition consisting of basic entities that include processing elements, storage devices, transfer devices, and software modules. Each processing element has a set of instructions. Software modules, which consist of instructions, run on processing elements. These modules have fixed or probabilistic execution times. Processing elements can send messages via transfer devices to other processing elements or to storage devices. Messages queue at processing elements where they are processed by software modules. Also, software modules can queue for execution on processing elements. Network II.5® provides information on queue lengths and queueing delays, and it features scheduling mechanisms and priority disciplines. A random number generator and most of the commonly used statistical distributions are built into Network II.5®. Although Network II.5® is written in Simscript II.5®, no interface is provided to user-written Simscript II.5® code. A description of Network II.5® is provided by CACI [CACI, 1989].

Network II.5® contains built-in models for transfer devices that use collision, token ring, and other protocols. A specific LAN segment is, therefore, modelled by an appropriate selection of parameters. In addition to the built-in network protocols, Network II.5® provides the primitives necessary to model networking devices such as bridges, routers,

gateways, communications controllers, and front-end processors.

Network II.5® does not model at the physical layer. Thus, it does not model signal propagation along with phase shift, jitter, and error conditions. Network II.5® has a fixed sized collision window for each Ethernet® segment, whereas in reality it is a function of distance. Also, the inter-frame gap is fixed for a LAN. Thus, Network II.5® cannot handle variations in Network Interface Unit (NIU) speed that result in varying inter-frame gaps [Rickert, 1990].

BRIDGE AND ROUTER ARCHITECTURE

Bridges and routers, typically, are microcomputer based and use a common chip, such as the Intel 80286® or the Motorola 68020®. They generally use a standard bus, such as VME® or Multibus®, which accommodates processor and memory modules, as well as the NIUs. Figure 2 illustrates the typical architecture used for bridges and routers. There are variations on this basic architecture, such as memory on the NIU board itself. Although an advantage in that the board provides additional memory, such an architecture can actually perform slower because the processor may be required to move data from the memory on one NIU to the memory on the other NIU.

A different type of router architecture that has been introduced recently is a dual-bus architecture, illustrated in figure 3. High-speed NIUs are interfaced to a high-speed bus, whereas slower NIUs are connected to a slower bus. Since simultaneous transfers can be performed on each bus, the performance threshold of the router is higher than a single bus architecture. A reason for retaining the slower bus (instead of using two high-speed buses) is to provide upward compatibility from older products that could only interface to the slower bus.

Vendors have recently introduced high-end products based on a distributed processing architecture, as illustrated in figure 4. The processor is usually the bottleneck in single processor designs, such as that of figure 2. Hence, performance can be improved either by a more powerful single processor or with multiple processors. Since the latter provides a higher performance threshold than the most powerful single microprocessor, vendors have recently come out with high-end routers based on distributed processing.

In the architecture of figure 4, the CPU performs control and monitoring functions. Although it may initiate transfers, the CPU does not participate in the actual data transfers between NIUs. Traffic between LANs that are connected to the same board in the router does not use the bus. Such multiple transfers can occur simultaneously without contending for resources, except for use of the CPU for initialization. Traffic between LANs that are connected to different boards does use the bus. Although the bus can interleave multiple transfers, there is contention for bus access, and this can limit throughput.

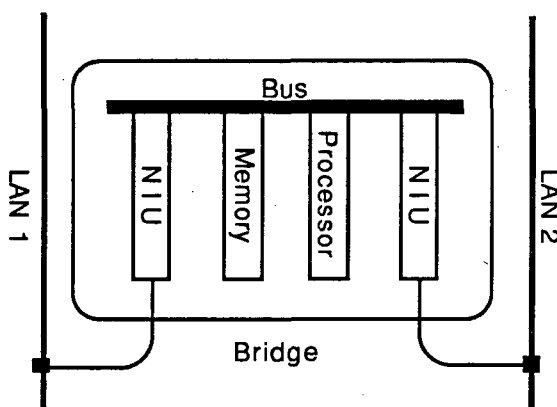


Figure 2: Typical Bridge/Router Architecture

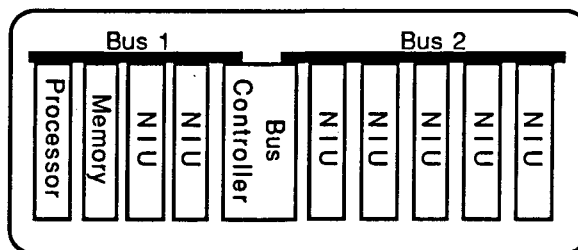


Figure 3: Dual-Bus Router Architecture

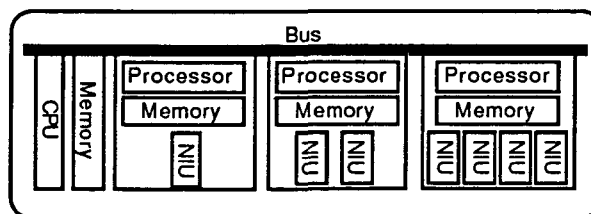


Figure 4: Distributed Processing Router Architecture

Although simple routers and bridges connect to just two LANs, the high-end products can connect several LANs. This has led to their use as hubs [Korzeniowski, 1990], as shown in figure 5. Figure 6 shows an expanded view of a router configured to perform as a hub that interconnects one FDDI, one token ring, and four Ethernet LANs. In such a configuration, the bus of the router serves as the backbone. With a 32-bit bus, a transfer rate in excess of half a Gigabit/sec is claimed [Desmond, 1990].

PERFORMANCE MODELS

Performance models of bridges and routers were developed using Network II.5®, based on vendor-provided information about the architecture and performance of each device. Given the architecture, its

translation into Network II.5® terms was fairly straightforward in most cases. Buses were modelled as Network II.5® transfer devices, processors as Network II.5® processing elements, and NIUs were modelled as processing elements with buffer memory and I/O delays. Packet generation was by means of a Poisson process built into Network II.5®. The models were calibrated using reported performance data. Since several parameters were adjusted, many simulation runs were required for each model.

The data collected from the simulation runs included queue lengths, packet transfer times, and utilization of various resources such as processors, buses, and LANs. Due to the limited graphics capability and report generation capability of Network II.5®, it was sometimes necessary to use other software

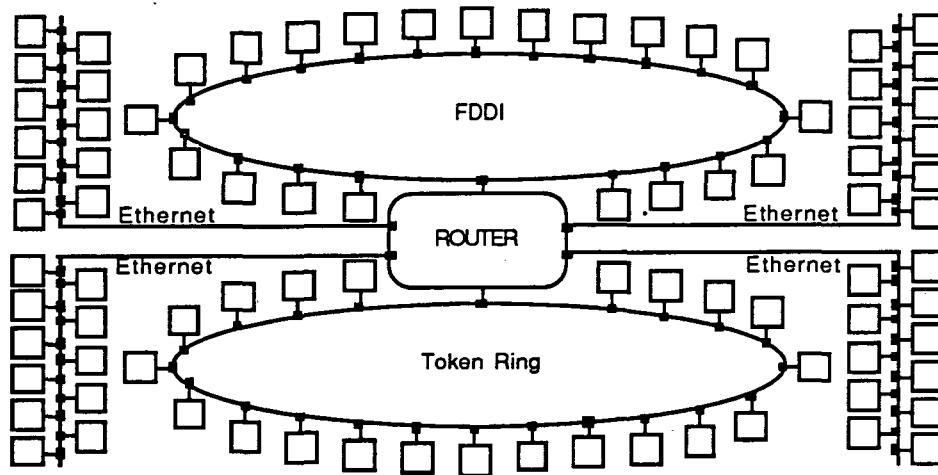


Figure 5: A Router as a Hub

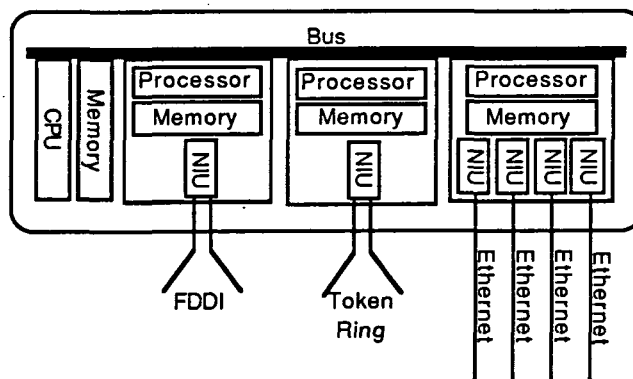


Figure 6: Configuration of a Router as a Hub

packages to analyze, format, and present the data generated by Network II.5®.

RESULTS

The results of the performance analysis of some devices are presented here. The first of them is an Ethernet bridge. The processor in the bridge was a Motorola 68020® running at 20 MHz. The bridge used a Multibus® to connect the processor, memory, and two NIUs. It ran a Unix® kernel, optimized specifically for the device. The maximum unidirectional scan rate of the bridge was specified as 14K packets/sec, and the maximum bidirectional scan rate was listed as 22K packets/sec. The maximum forwarding rate was listed as 10K packets/sec. The packet delay, defined as the time from the end of packet reception to the start of packet transmission, was specified to be 150 μ s. These performance specifications were used to calibrate the model. Bridge performance was studied for packet sizes ranging from the Ethernet minimum of 46 data bytes to the Ethernet maximum of 1500 data bytes. Several scenarios were investigated, and one of them is presented here.

Figures 7(a) and 7(b) illustrate the scenario where the bridge is forwarding packets in both directions. In this case both LANs had a random mix of packets, 50% of which had to be forwarded across the bridge. The maximum bidirectional forwarding rate that was achieved was 5800 packets/sec, in contrast to the vendor-rated 10,000 packets/sec. When packets arrived faster than 5800 packets/sec, some of them would be lost. For maximum-size packets, the bridge forwarded 1600 packets/sec. However, the amount of data forwarded by the bridge increased with packet size. This is illustrated in figure 7(b).

Figure 8 shows the performance of three bridges. Bridge A was based on a Motorola 68000® running at 12 MHz, and its transfer rate was specified as 7000 packets/sec. Bridge B is the one presented earlier in figures 7(a) and 7(b). Bridge C is a recently introduced high performance bridge with a multiprocessor architecture that contains a Motorola 68030® CPU. Bridges A and B differ noticeably only for small packets. However, bridge C can forward at a higher rate than the others for all packet sizes.

The performance of two routers is illustrated in figures 9(a) and (b). Both routers were single protocol devices that routed TCP/IP over Ethernet. Both utilized a single processor and were based on an architecture like that in figure 2. Although the

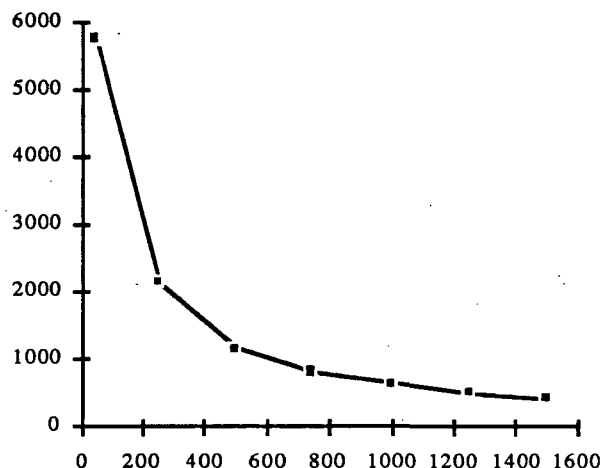


Figure 7(a): Bidirectional Bridge Throughput (packets/sec vs. packet size in bytes)

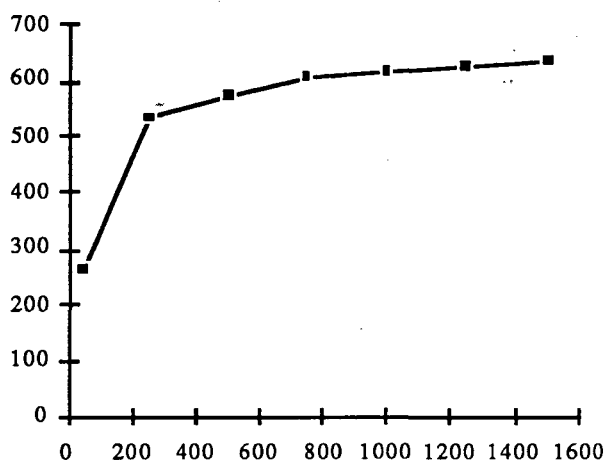


Figure 7(b): Bidirectional Bridge Throughput (Kbytes/sec vs. packet size in bytes)

routers could be configured with several Ethernet NIUs and were capable of routing multiple streams simultaneously, performance data was available only for routing a single stream. Figure 9(a) shows the unidirectional performance of the two routers in a scenario where all packets were forwarded and there was no other traffic on the two LANs connected to the router. As can be seen in the figure, the performance in terms of packets/sec decreased as packets size increased. However, as illustrated in figure 9(b), the amount of data forwarded by the router increased with packet size.

A router provides the capability to filter packets based on specified conditions, i.e. the router forwards only packets whose address information meets specified conditions. The conditions are based on a network management approach and are entered into a router when it is configured for operation. Checking filter conditions imposes an additional burden on the router and can affect its performance. This is illustrated in figure 10, which shows the performance of a router without filters, with one filter, and with ten filters. The router whose performance is shown in figure 10 is different from, and faster than, the ones whose performance is shown in figures 9(a) and 9(b).

Routers with a distributed processing architecture (as shown in figure 4) forward packets at different rates depending upon whether the forwarding is performed within a board or whether it is performed across boards. In the latter case, the data must be forwarded on the bus and, depending upon the router software, the process may impose a larger burden on the CPU. The performance of such a router is shown in figure 11. As can be seen in the figure, this router performs consistently better when forwarding packets within a board than for forwarding packets from one board to another.

CONCLUDING REMARKS

The rationale for modelling bridges and routers has been presented in this paper. The tool used for the study has been described, along with the architectural considerations of bridges and routers that are pertinent to modelling. The results of the performance analysis of some bridges and routers have been presented. Performance data, such as that presented here, can be used in selecting bridges and routers. Models, like the ones described here, can be incorporated into an integrated network model that predicts various aspects of network performance for the wide range of conditions that are encountered in actual operation. The model can be used to assess the impact of changes in network configuration, including the selection and configuration of bridges and/or routers within a network.

ACKNOWLEDGEMENT

This work was sponsored by NASA contract number NAS9-18057. Some of the performance data used in this study was provided by Scott O. Bradner of Harvard University.

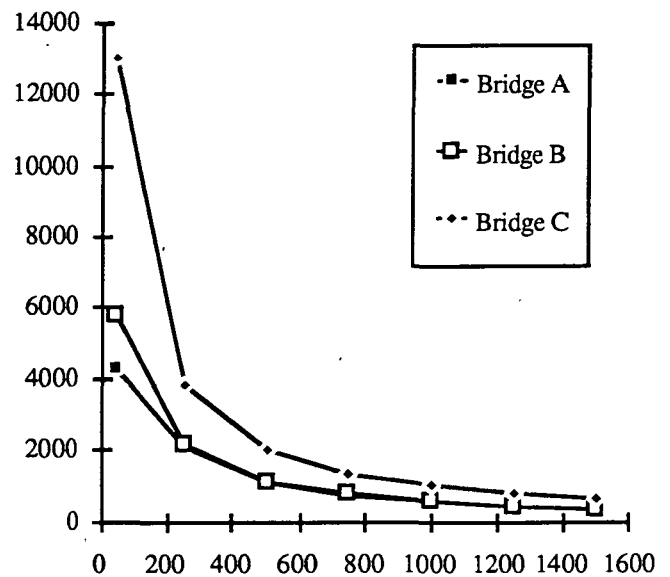


Figure 8: Bidirectional Throughput of Three Bridges (packets/sec vs. packet size in bytes)

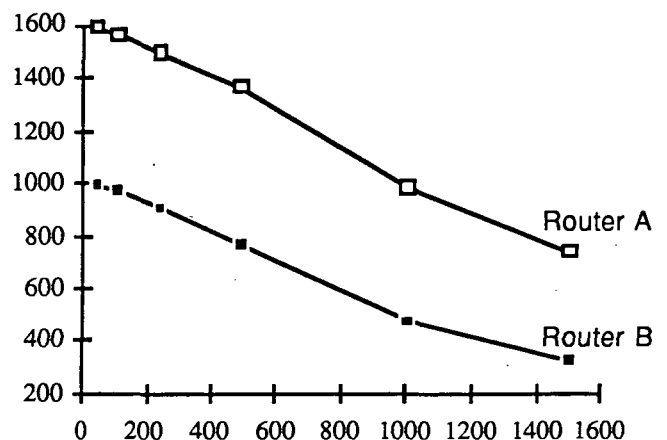


Figure 9(a): Router Performance (packets/sec vs. packet size in bytes)

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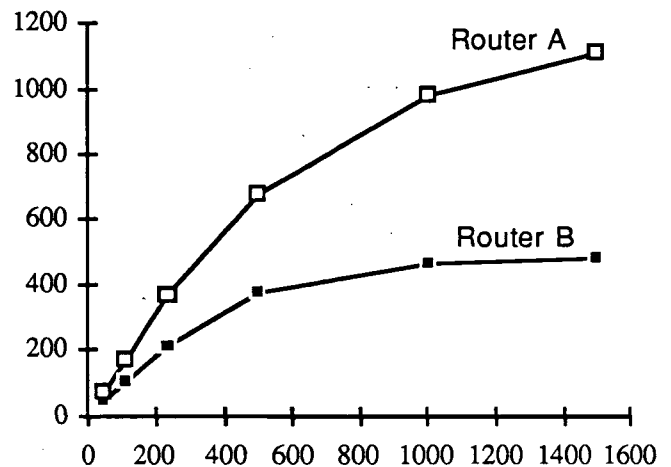


Figure 9(b): Router Throughput (Kbytes/sec vs. packet size in bytes)

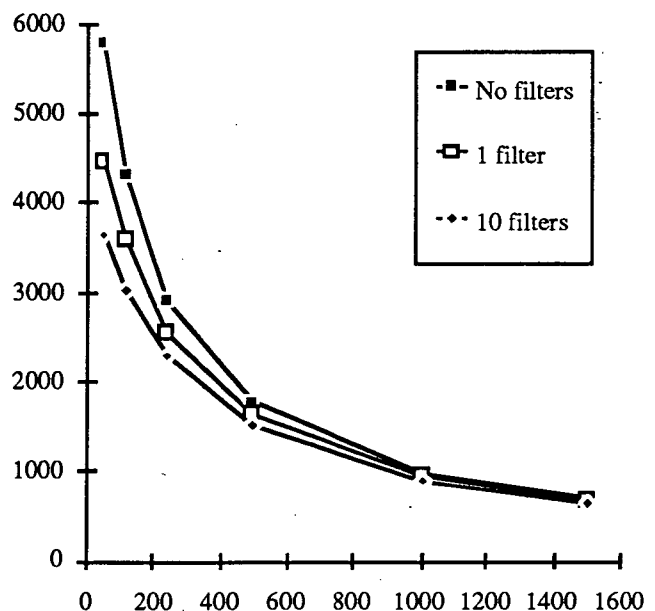


Figure 10: Router Performance with Filters (packets/sec vs. packet size in bytes)

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LIST OF ABBREVIATIONS

CIN	Center Information Network
CPU	Central Processing Unit
DEC	Digital Equipment Corporation
IPX	Internetwork Packet Exchange
NASA	National Aeronautics and Space Administration
MAC	Media Access Control
MHz	megahertz
μ s	microseconds
NIU	Network Interface Unit
LAN	Local Area Network
OSI	Open Systems Interconnection
sec	second
TCP/IP	Transmission Control Protocol/Internet Protocol

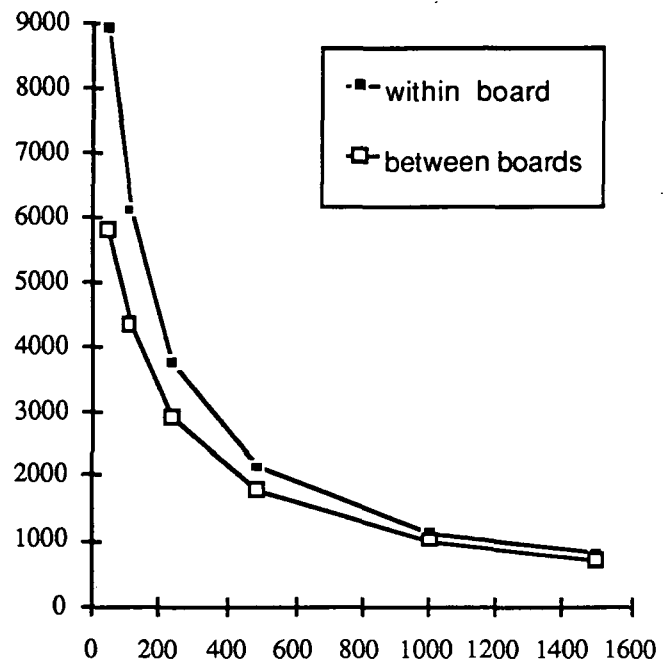


Figure 11: Router Performance
(packets/sec vs. packet size in bytes)

Networking and the Transformation of Work

Dr. Anthony Gorry, Ph.D.

Information Technology Programs, Baylor College of Medicine

Abstract

Computing, networking and related technologies hold great promise for information acquisition, sharing and management in organizations. But the full benefits of information technology will accrue to those companies and institutions in which leadership is coupled with a vision of the important changes in work that the technology will induce.

We will require a rethinking and perhaps a redesign of many of the aspects of organizational life, if the full benefits of the developing technology are to be realized. The impact of information technology on organizations will not be determined by computing alone. New skills, new behavior, will be required of those who want to exploit this technology.

Commonly scenarios of the future envision advanced technology such as networking supporting organizational structures and processes that are essentially unchanged from today. We should concern ourselves as well with the ways in which computing will permit a new conceptualizing and organization of work and the way in which it will call forth new behaviors. Profound changes in the nature of work, induced by developments in computing and its related technologies, will almost certainly change companies and institutions in the decades to come.

Session 3

Systems for Group Support

Chair: Dennis Adams, *University of Houston*

N92-12502

Group Decision Support Systems
Don Petersen, *Collaborative Technology Corporation*

Abstract

This talk will look at using computers to support collaboration among members of a business team. The specific application is the augmentation of meetings. The motivation, approach, and empirical results will be presented.

"What matters most today is the ability to think together, not alone."

**Harvard Business Review
Thinking Across Boundaries
November-December, 1990**

Collaborative Technologies Corporation

Premise

- **Most business work involves a large amount of group work**
- **Most group work involves problem solving**

Collaborative Technologies Corporation

What is the task of group work in business teams?

- **Problem solving**
 - **Surface and share ideas**
 - **Surface assumptions**
 - **Evaluate, prioritize, and allocate**
- **Document the process and the results**

Why business teams at this time?

- **Flatter and less bureaucratic organizations**
 - **Cross functional teams**
 - **Pace of change**
 - **Competition**
- **Quality improvement programs**

Malcolm Baldrige National Quality Award

- **Established by the U.S. Congress three years ago**
- **In 1990, 167,000 different companies requested information**
- **Comprehensive, top to bottom assessment of a company**
 - **People**
 - **Processes**
 - **Principles**
- **A shared commitment**
 - **Continuous improvement**
 - **Continuing attention to the customer**

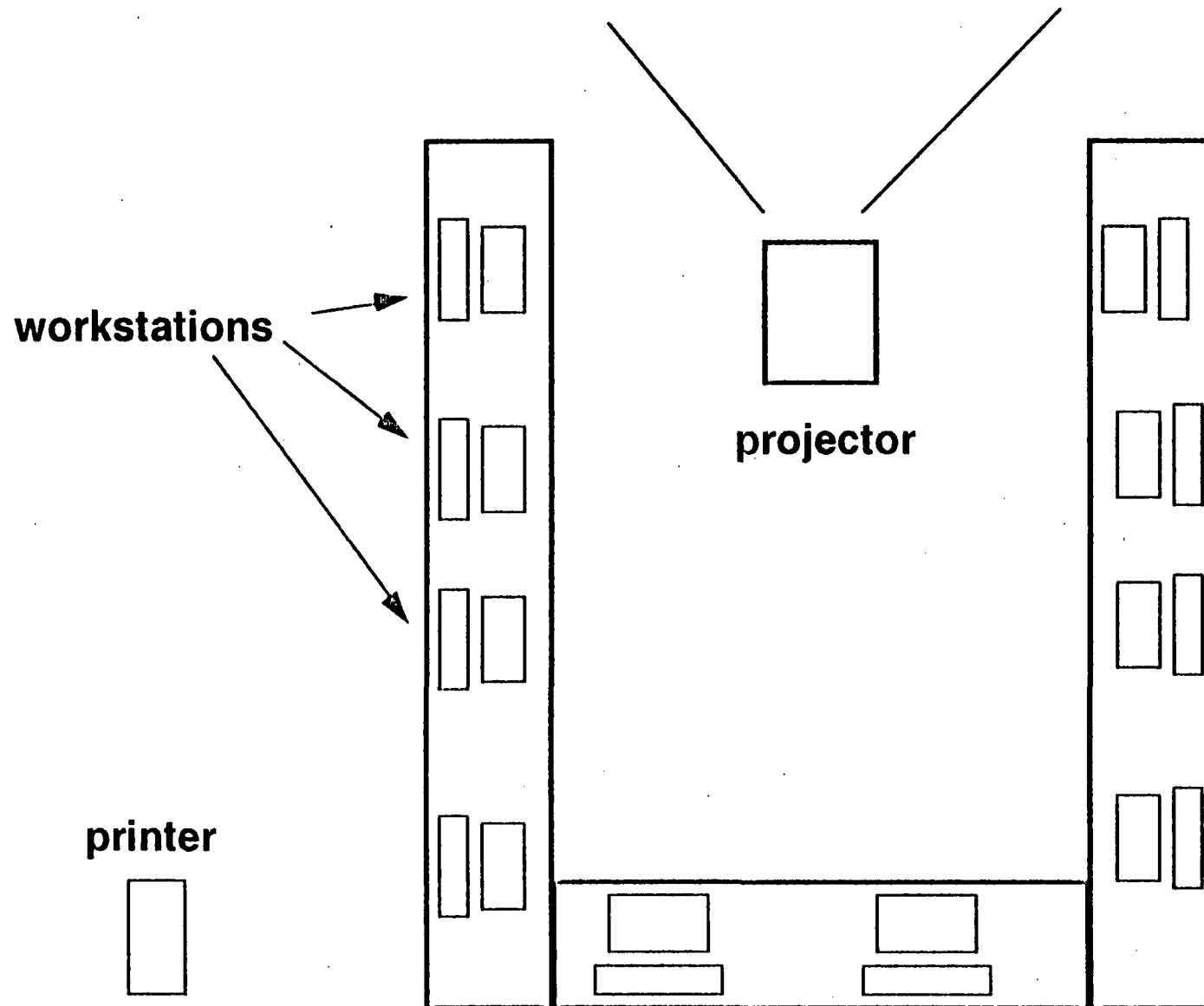
Why software to support business teams at this time?

- **Emphasis on teams within industry**
- **Global communications**
- **Availability of enabling technology**
- **Clearly demonstrated need and solution**
- **Hot research topic**

What are the major areas of Groupware?

- **Cooperation**
 - **Email**
 - **Notes programs and bulletin boards**
- **Collaboration**
 - **VisionQuest from CTC**
- **Coordination**
 - **Cooperation from NCR**

Meeting Room Layout



Collaborative Technologies Corporation

VisionQuest supports the decision processes of

- **Exploration**
- **Distillation and synthesis**
- **Evaluation**
- **Prioritization**
- **Allocation of scarce resources**
- **Documentation**

Meetings can be held without regard to time or place

Collaborative Technologies Corporation

Empirical Data

**Implementing Electronic Meeting Systems at IBM:
Lessons Learned and Success Factors
Grohowski, McGoff, Vogel, Martz, Nunamaker**

- **Number of person-hours per session declined 56%**
- **Total number of person-hours declined 62%**
- **Calendar time for a project was reduced**
- **Number of meetings necessary to complete project declined**
- **Automated group hour equals 2.61 manual group hours**

Typical reactions from participants

- **"Wow, we accomplished a lot!"**
- **"Wow, we were surprised about what other people were thinking!"**
- **"We just never would have thought about that!"**
- **"Gee, it is nice to have a complete record of meeting events to carry with us."**
- **"Unbelievable how fast the time passed!"**
- **"It's wonderful how this helped us understand how we arrived at a decision."**

N92-12503

Computer Conferencing: Choices & Strategies

Jill Y. Smith, *University of Denver*

Abstract

Computer conferencing permits meeting through the computer while sharing a common file. The primary advantages of computer conferencing are that participants may (1) meet simultaneously or nonsimultaneously (2) contribute across geographic distance and time zones. Due to these features, computer conferencing offers a viable meeting option for distributed business teams. The presentation summarizes past research and practice denoting practical uses of computer conferencing as well as types of meeting activities ill suited to the medium. Additionally, the presentation outlines effective team strategies to maximize the benefits of computer conferencing.

COMPUTER CONFERENCING: CHOICES AND STRATEGIES

Jill Y. Smith
University of Denver
Department of Management Information Systems
Denver, CO 80208

ABSTRACT

This paper connects the growing popularity of distributed business teams with the feasibility of supporting team meetings with a nonsimultaneous (or asynchronous) computer conference. The conclusion is that a properly designed nonsimultaneous computer conference may render a competitive advantage to firms wrestling with the problems of managing the multi-site interdependence characteristic of distributed business teams. However, design issues are difficult and attempts to directly substitute a nonsimultaneous computer conference for a face-to-face conference are likely to fail. Text discussion addresses why this communication medium is different and the known advantages and limitations inherent in computer conferencing. A brief discussion summarizes present and state-of-the art computer conferencing technology to provide context for the major contribution of the paper. That contribution is CELRUA, or a set of strategic guidelines salient in the design and implementation of a nonsimultaneous computer conference.

COMPUTER CONFERENCING: AN INTRODUCTION

Our fundamental thesis is that a firm's ability to continuously improve the effectiveness of managing interdependence is the critical element in responding to new and pressing competitive forces. Unlike in previous eras, managerial strategies based on optimizing operations within functional departments, product lines, or geographical organizations simply will not be adequate in the future.
(Rockart and Short, 1989)

Computer conferencing (CC) offers a forum for an electronic meeting. CC technology supports group interaction on a defined task; communication is largely text based, however graphics and data may be exchanged as well. CC differs from EMail in that CC provides a common environment for topic discussion rather than the exchange of discreet comments.

Participants may elect to meet through a CC simultaneously. However, the distinguishing characteristic of a CC from other computer-mediated meeting channels (e.g. audio or videoconferencing) is the ability to hold a nonsimultaneous (or asynchronous) meeting. Not having to be present in real time means that participants can transcend geographical and temporal constraints. Additionally, participants may work on different agenda items according to their talents and are not constrained by group progression through an agenda (Turoff 1991). The theme of this paper is that the nonsimultaneous CC may render a competitive advantage to firms wrestling with the problems of managing multi-site interdependence.

COMPUTER CONFERENCING AND DISTRIBUTED BUSINESS TEAMS

CC is a technology worth exploring to support the communication needs of an increasing phenomenon, the geographically distributed business team (Kutsko and

Smith, 1991). Business is now acutely aware of the need for high performance business teams and many said teams operate from multiple physical locations. Sometimes the teams represent permanent functional workgroups such as purchasing agents located at different plants. However, other teams are formed as ad-hoc task forces. Johansen (1988) typifies the latter as fluid organizational forms whose members are assigned (and reassigned) based on their ability to contribute, not on their position in the organizational chart. Examples of organizational teams include project teams, brand teams, sales teams, account teams, new-product teams, and crisis-response teams.

Often these teams are cross-functional and perform in a decentralized, matrix environment. Herein lies the opportunity and challenge for CC technology. Present CC meeting advantages accrue primarily in (1) coordinating activities, (2) generating and organizing information, (3) asking and responding to inquiries, and (4) controlling work flow.

However, these benefits are not automatic because CC is not a direct substitute for a face-to-face conference and the medium is apt to fail when considered a substitute (Johansen, 1984). For example, information filtering and organization techniques available in state-of-the-art CC systems create capabilities not present in face-to-face meetings. Alternatively, face-to-face communication is certainly richer in communication channels (voice intonation, eye contact, posture, dress, etc.) The problem is to understand the dynamics of the CC experience and to forge a match between distributed business teams communication needs and CC capabilities.

PRESENT MARKET AMBIVALENCE TOWARD CC

Past research and practical experience with CC creates polarized opinions and is no doubt related to the present rather ambivalent market acceptance of CC software (Straub and Wetherbe, 1989). Typical pro and con CC sentiments are listed below. Quotations illustrating each statement come from the book Electronic Meetings (Johansen et al. 1979, pp. 61-79).

Pro CC Sentiments:

1. CC is valuable for presenting technical information.

For accuracy's sake, I think it might be best to stick to computer conferencing. In other meetings, a lot of technical errors go unnoticed.

2. CC allows vigilance at home while meeting with people elsewhere.

I'm really glad I can visit local groups here during the day and still be an active participant in this conference.

3. CC provides a written transcript which provides continuity between meeting sessions as well as a written record.

In my opinion, the transcript is one good argument for continuing in this conference.

4. CC enables "back burner", careful, objective consideration of the issues.

Computer conferencing works well for me. I can file my reports at any time of the day, have a permanent record, and can check to see if what I am sending is accurate. It enables us to deal objectively with a mass of data.

5. CC promotes egalitarian participation for shy personalities and for individuals who may be stymied in face-to-face conversation with authority figures.

I'm glad to see Professor Pierson speaking up in this conference. He is really a strong thinker, but I know he is also very shy in meetings. A colleague of mine attended a large international conference in Montreal where he was also in attendance, but didn't say a word!

Con CC Sentiments:

1. CC is ill suited to resolving interpersonal problems.

...I think we should try to avoid solving interpersonal problems in this medium. Remember when we were having trouble with the LCF data base and we attempted to solve it over the terminal? We were trying to help, but each message came out like judgments in a criminal court.

and

In retrospect, I can see that the basic flaw in the conference was the overemphasis on the value of information in solving a culturally complex problem. With one or two possible exceptions, we failed to acknowledge the importance of the interpersonal aspects of the meeting--the building and maintenance of alliances.

2. CC meeting formats may provide too much structure.

It was structured so rigidly that we never had a chance to get basic concerns out in the open.

3. CC meetings often suffer from information overload.

We finally reached a complete impasse when there was more data than any of us could absorb!

4. CC meetings require self-regulation to participate. Unevenness of participation can create feelings of mistrust and isolation.

One of the most serious [manifestations of mistrust] was the unevenness of participation. Some people responded to new entries every day. Others responded only irregularly.

Such an atmosphere understandably tends to make organizations leery of CC. Many organizations have piloted CC and given up either through bad experiences or inertia (Johansen, 1988). What is not apparent in the above comments is that end

users must apply any communication technology, including CC, appropriately to a true business need. "Applied appropriately" means that designers concentrate equally on the communication needs and technical capabilities. According to Bikson and Eveland (1986 p. 9), "...we cannot appreciate what a tool is until we see what it does -- or better yet, use it ourselves to do something we value having done."

The following section presents a synopsis of present and future CC technology. Then discussion summarizes CC potential and limitations through the lens of communication theories and past research/practical experience. The remainder of the paper recommends technical and organizational design strategies to examine the "fit" between the communication needs of distributed business teams and CC capabilities.

COMPUTER CONFERENCING TECHNOLOGY

CC belongs to a family of computer-mediated communication systems including EMail, facsimile, computer-bulletin boards, videotex, voice messaging, and videoconferencing. The intention of CC design is to support the group and the application (Turoff 1991). However, to date the basic CC format available to organizations provides minimal support. Two formats are widely available. One consists of a common file to which conference participants write comments in sequential order (e.g. EIES). A second is a reply oriented system where respondents respond to new comments as they arrive (e.g. Confer). Generic facilities support (1) keyword searches, (2) links between various topics, (3) defined participant roles and privileges, and (4) the ability to track each participant's progress through the transcript. Generally, private message capability complements the group conference.

Advanced features lend more support. For example, an agenda may allow participants to pursue major points (not necessarily in sequential order). Additionally, structure may support a decision making process such as the Delphi method or nominal group technique. Feasible too are electronic questionnaires, graphics, and an array of voting techniques.

In the future, CC products may incorporate additional "groupware" features (Johansen, 1988). Prototype facilities exist for (1) hypertext to improve message linking, (2) text filtering to cope with information overload, (3) group authoring software, (4) decision aids and artificial intelligence protocols to structure problem solving and decision making, and (5) conversational structuring to better manage and administer projects. To a limited extent, some of these features are commercially available today.

CC POTENTIAL AND LIMITATIONS: SOME CAVEATS

Communication theories (Fulk et al. 1990, Daft et al. 1987, Short et al. 1976, Rice 1987) and practical experience lend insight on nonsimultaneous CC shortcomings and promise. Limited presently to a largely text-based format, CC conferees experience difficulties conveying interpersonal information and using the medium for consensus building and decision making activities (Smith and Vanecek,

1990). Without sufficient group norms to respond promptly, questions go unanswered and mistrust develops with perceived isolation. This has led to the conclusion that text-based mediums are optimal for information exchange, coordination, asking questions, keeping informed, and reducing uncertainty with swift communication (Rice, 1984; Kydd and Ferry, 1991). At times CC meetings are more successful when participants have pre-conference face-to-face get togethers to develop mutual trust.

However, research examining past CC transcripts indicates that interpersonal communication is present and the inclusion of social and emotional comments may be more related to experience with the medium and to group norms than to the medium itself (Rice, 1987; Chesbro, 1985; Steinfeld, 1986). Additionally, the need for interdependent communication by people at different locations and time zones may moderate a natural preference for face-to-face or telephone communication channels (Rice, 1987). This is the "mother is the necessity of invention" syndrome.

CC design and effective use depends on two caveats. First, the technical design must provide mechanisms both to deal with information overload (e.g. text filtering), and to provide balance between conversation structure and freedom to pursue new avenues of thought (e.g. hypertext). Second, the distributed team members must buy into the idea of a nonsimultaneous meeting and perceive personal benefits greater than costs (Grudin, 1988). Benefits point to an augmented capability to work interdependently from a distance. Costs encompass the time and energy necessary to develop and learn new group processes for expressing interpersonal messages that will not be misinterpreted. Costs also include a group norm for self-regulated meeting "attendance." The concluding section outlines strategic considerations in planning a CC to support a distributed team.

CC STRATEGY, THE CELRUA GUIDE

Capitalizing on communication need, distributed business teams have an opportunity through CC to augment their communication capabilities. Teams can configure the technology, task, and group process norms and create a new communication skill -- a nonsimultaneous meeting.

Strategic decisions discussed below begin with the strategy developed in the book Teleconferencing and Beyond (Johansen, 1984). The basic strategy has been expanded and targeted specifically to issues salient in the implementation of a nonsimultaneous computer conference. "CELRUA" is an acronym for the strategy derived from the imperative verbs beginning each guideline.

Complete and accurate needs assessment. Establish the critical success factors to meet key unmet business needs. Example needs of distributed teams suggesting a nonsimultaneous CC are:

1. A sales force that needs current product information.
2. An ad hoc task force or project team which needs to communicate across geographic and temporal barriers.

3. Vigilance on the home front or security issues prohibit travel.
4. A competitive requirement exists for swift task completion.
5. Planning and coordination of the work flow is crucial.
6. Technical information changes and team members must know about the changes.
7. A focus on quality management mandates participatory management across distance.

Establish a clear, immediate benefit. Change will always be difficult, but a clear, immediate benefit for a pressing problem may provide the necessary impetus to change traditional communication patterns. Identify a communication bottleneck limiting the performance of a distributed team and pilot a nonsimultaneous CC. A successful initial experience may expand insights on the use of the medium.

Learn from experience. Cumulative past experience from MIS, OA, and teleconferencing implementation failures is transferable to the CC context. Technological innovations need a senior management advocate and that advocate should be both visible and present at least through the initial pilot. Sometimes referred to as the "information technology champion," this individual "has the vision, keeps pushing when the going gets tough, generates creative energy, and makes it happen" (Cook, 1988).

Past lessons demonstrate that CC will not work if brought in as a toy or if users do not perceive a clear benefit. Additionally, CC use will be minimal if the learning curve is complex and no time is allotted to learn or share experiences. Finally, team members must have a sense of ownership. Preferably, adoption will be a team choice or, at least, team members should have strong inputs to both the technical and group process design choices.

Recognize company/team culture and individual differences. Existing groups have both task and maintenance components. Maintenance components reflect group norms for working together. Face-to-face groups typically have norms about (1) where people sit in a conference room, (2) communication turn-taking, (3) clout of individual team members based on seniority, respect, or power, (4) amenities available in the conference room, and (5) acceptance of supporting technology. Often maintenance factors operate without conscious discussion or even group awareness. However, given the limited communication channels available in a CC, maintenance factors need design attention, not just happenstance. For example, a CC may provide a conference "space" solely for social interaction.

Do not Underestimate the technical complexity of CC design. Preferably, CC technology supports generic group processes rather than any specific task. In this respect, CC technology is analogous to a DBMS product which provides a common

user interface from which designers build specific database applications. However, CC design is more complex than database design because text is unstructured data. Creating a single user interface so that users can selectively contribute and weave their way through meeting content while simultaneously structuring group communication is a significant design challenge.

Educators creating on-line CC courses speak of the significant up-front tasks necessary to support a CC environment. None of the face-to-face props exist (e.g. tables, chairs, blackboards, coffee machines). The designer/instructor must create environmental spaces for social and cognitive interaction (Harasim, 1991).

Today's CC systems support idea generation far better than idea management. That is, brainstorming and reacting to other's ideas are not difficult; however synthesizing and making sense of those ideas is cumbersome. Advanced work (now commercially available) by Murray Turoff on EIES2 at the New Jersey Institute of Technology incorporates object-oriented design principles to better manage conference text (Turoff, 1991).

Address the problem of responsibility. As discussed above, designing a CC from a generic "tool set" is complex and time consuming. However, monitoring and "coaching" participants through both the social and cognitive task requirements mandates indispensable and constant attention by the conference "owner." At this time it is not clear who the "owner" should be -- the team leader or a separate CC facilitator. Given the multiple, simultaneous demands on team leaders and the necessity for quick response to CC participant questions, a separate CC facilitator is beneficial. Facilitator requirements include knowledge of the technology, task, and group maintenance norms necessary for a nonsimultaneous CC.

CONCLUSION

This paper describes the potential of a nonsimultaneous CC to meet the communication requirements of distributed business teams. Pro and con sentiments concerning CC illustrate the minimal acceptance of this communication medium to date. Basic present day limitations with nonsimultaneous, primarily text-based meetings center in three difficulties: (1) providing sufficient interpersonal communication and timely response, (2) managing information overload, and (3) striking a balance between structure and freedom to develop new avenues of thought. Newer technology (Turoff, 1991) may alleviate the latter two problems. Conscious CC design effort to provide appropriate group behavioral norms may address the first issue.

Recognizing the problems and limitations of CC technology, the central theme of this paper is that the communication requirements of distributed teams may stimulate interest in a nonsimultaneous CC. Exploiting that interest, the paper outlines design strategies, termed CELRUA, targeted toward social and technical considerations impacting CC implementation.

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Session 4

Network Applications

Chair: Steve Prejean, *GeoControl Systems*

N92-12504

Cross-Functional Systems

Mark Lee, *VALIC*

Abstract

Many companies, including Xerox and Texas Instruments, are using cross-functional systems to deal with the increasingly complex and competitive business environment. However, few firms within the aerospace industry appear to be aware of the significant benefits that cross-functional systems can provide. This presentation will cover those benefits and will also discuss a flexible methodology companies can use to identify and develop cross-functional systems that will help improve organizational performance. In addition, it will address some of the managerial issues that cross-functional systems may raise and will use specific examples to explore networking's contributions to cross-functional systems.

Objective

To Appreciate Cross-Functional Systems

- Definition & Benefits
- Methodology
- Key Requirements
- Question & Answer

Cross-Functional System

- Inter-Related Processes
- Unified Whole
- Common Purpose

Inputs

Processes

Outputs

Feedback

Benefits

- **Specific Accountability**
- **Improved Coordination between Units**
- **Greater Customer Satisfaction**

Methodology

Senior Management Tasks

- Identify Key CF Systems
Critical Success Factors
- Clarify Purposes
"WHY" before "HOW"
- Identify System Managers
Output Accountability

Methodology

System Manager Tasks

- Identify & Document
High-level flowcharts
- Track Performance
Value-Added to System
- Analyze & Redesign Processes
IT Capabilities
- Review Constantly
Continuous Improvement

Key Requirements

- **Senior Management Participation**
- **Independent Cross-Functional Consultants**
- **Cross-Functional Systems Training**
- **Integrated Information Infrastructure**

Networking's Contribution

- **Enables Communication & Coordination**

Texas Instruments

"WHY" before "HOW"

Accounts Payable

Mazda

Pay when
Receive
Goods

Ford

Pay when
Receive
Invoices

Withdrawal System

Inputs

Mailroom, Customer Service, Accounting

Outputs

Feedback

Supplemental Reading Materials

1. "Reengineering Work: Don't Automate, Obliterate," Michael Hammer, **Harvard Business Review**, pp. 104-112, July/August 1990.
2. "Process Management in Service and Administrative Operations," E.H. Melan, **Quality Progress**, pp. 52-59, June 1985.
3. "The New Industrial Engineering: Information Technology and Business Process Redesign," **Sloan Management Review**, pp. 11-27, Thomas H. Davenport & James E. Short, Summer 1990.

N92-12505

Cooperative Processing Data Bases
Juzar Hasta, *Gupta Technologies Inc.*

Abstract

This presentation will be about cooperative processing for the 90's using client-server technology; concepts of downsizing from mainframes and minicomputers to workstations on a LAN will be the main theme.

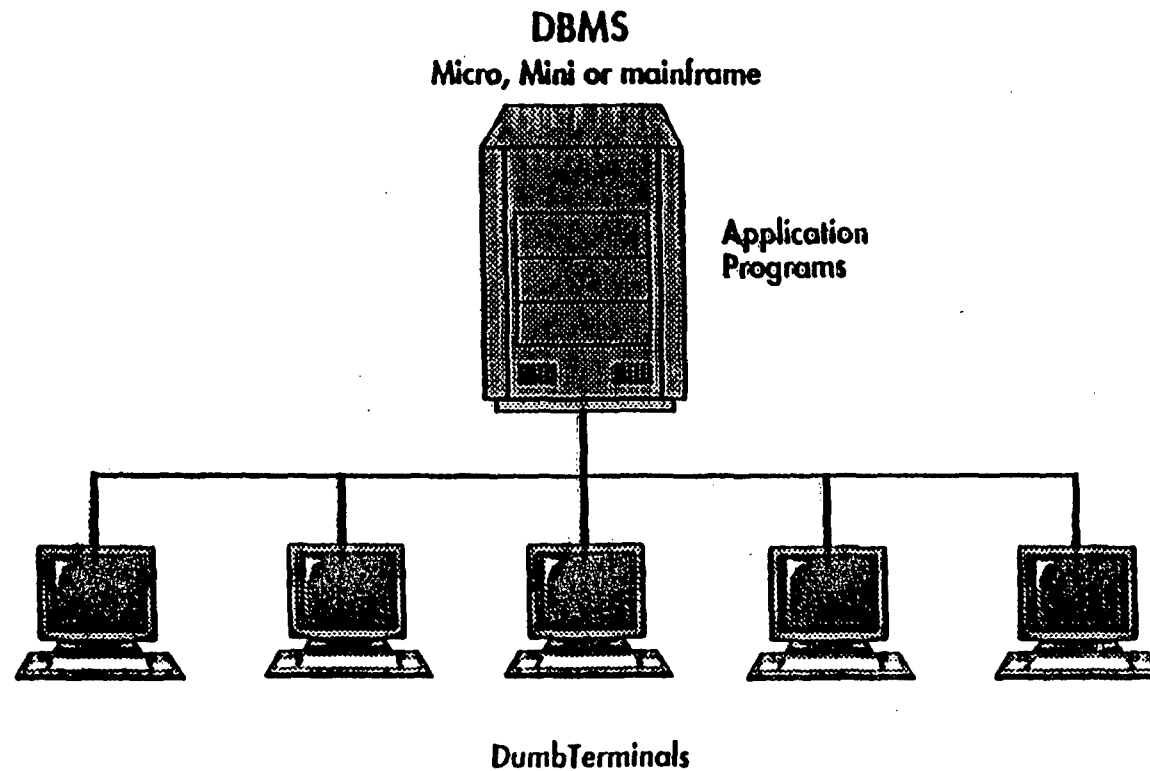
Graphical Front-Ends for SQL Back-Ends

Gupta

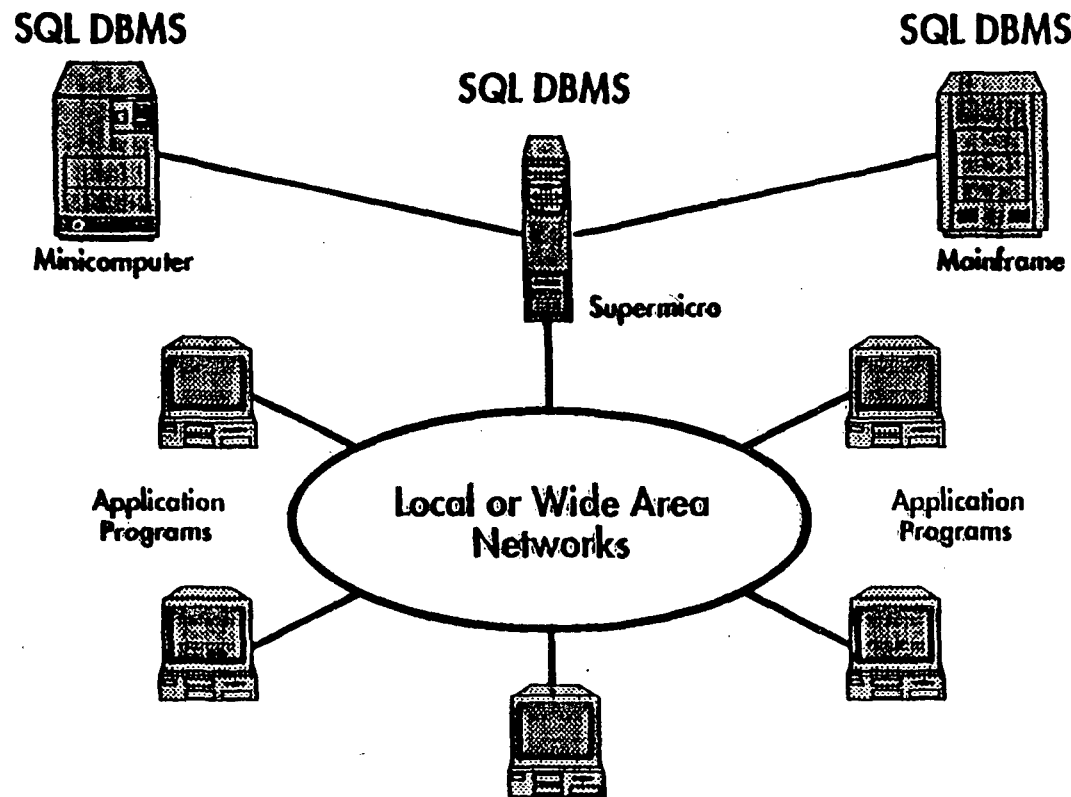
TECHNOLOGIES INC.

Gupta
TECHNOLOGIES INC.

Traditional Online Applications



Cooperative Processing Applications



SQL Cooperative Processing

When application programs run on PC workstations but transparently access SQL databases which reside on mainframes, minis, or micro based data servers.

Graphical Front-Ends for SQL Back-Ends

What makes an application graphical?

Elements of a Graphical Application

- **Bit Map Graphics**
- **Dialog Boxes**
- **Point Devices**
- **Windows & Scroll Bars**
- **Color & Fonts**
- **Text & Graphics**

Graphical Programming for SQL

- Visual display of code
- Point & click drawing of objects
- Events & messages
- Procedural actions
- Explicit SQL coding
- Reusable functions
- Animated debugging

Graphical Front-Ends for SQL Back-Ends

**Graphical programming for Windows
and OS/2 PM**

End-User Graphical Tools

- **Primarily for decision support**
- **Ad-hoc query and reporting**
- **SQL must be invisible**
- **Integration with spreadsheets/WP**
- **Easy application generation**

PC DBMS Software in the Nineties

Software

Graphical PC tools for
SQL databases

PC LAN client/server SQL
systems

Enterprise-wide PC to
SQL cooperative processing

Benefits

Improved people productivity

Downsize from minis and
mainframes

True integration of PCs into
corporate data processing

Future of Graphical Interfaces

- **Most PCs will go graphical within 3 to 5 years.**
- **Windows and OS/2 PM will be the dominant graphical environments.**
- **Graphical Front-Ends will drive Cooperative-Processing applications.**
- **Programmer tools will become more sophisticated, yet simpler.**
- **End-User tools will become more powerful.**

The Significance of SQL

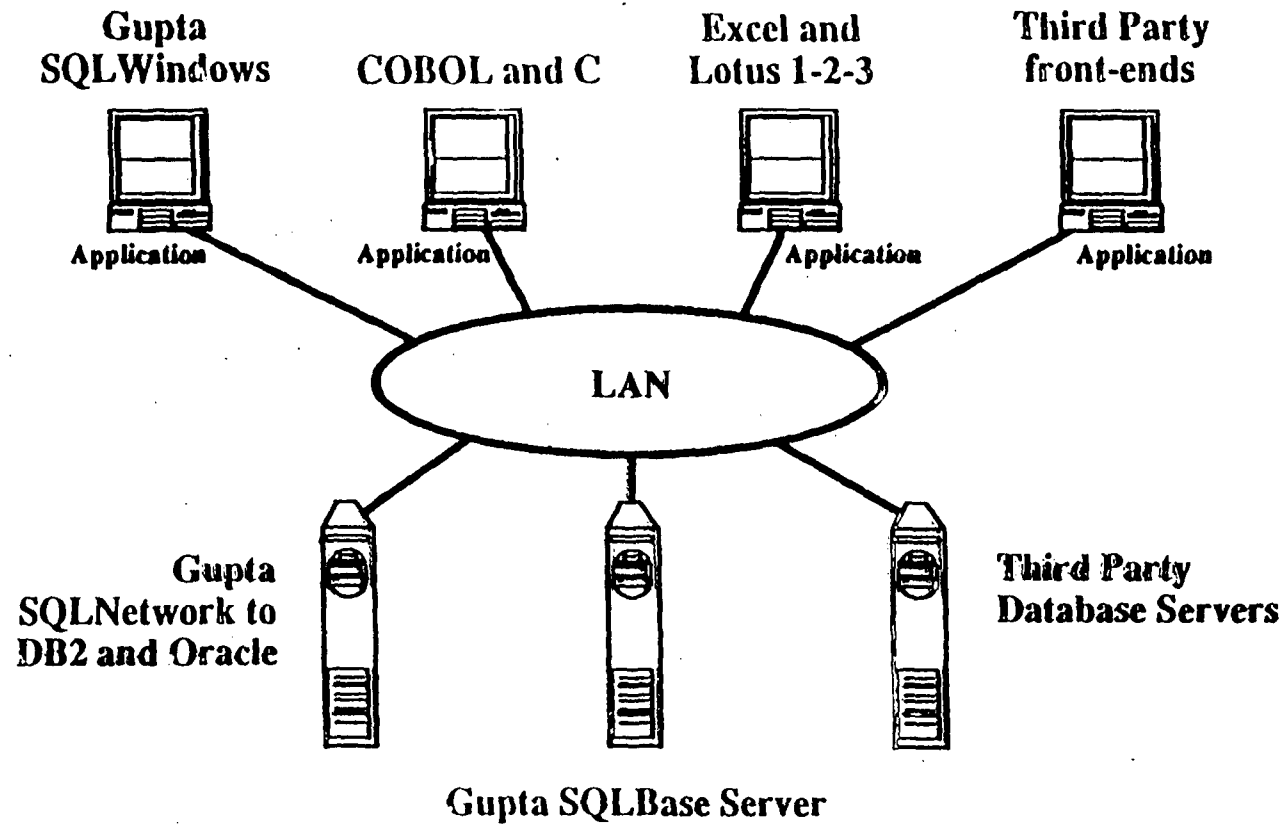
- **SQL makes it possible to develop LAN database servers.**
- **SQL enables development of engine-independent application tools.**
- **SQL provides unified access to micro, mini, and mainframe databases.**

We Open Windows to SQL

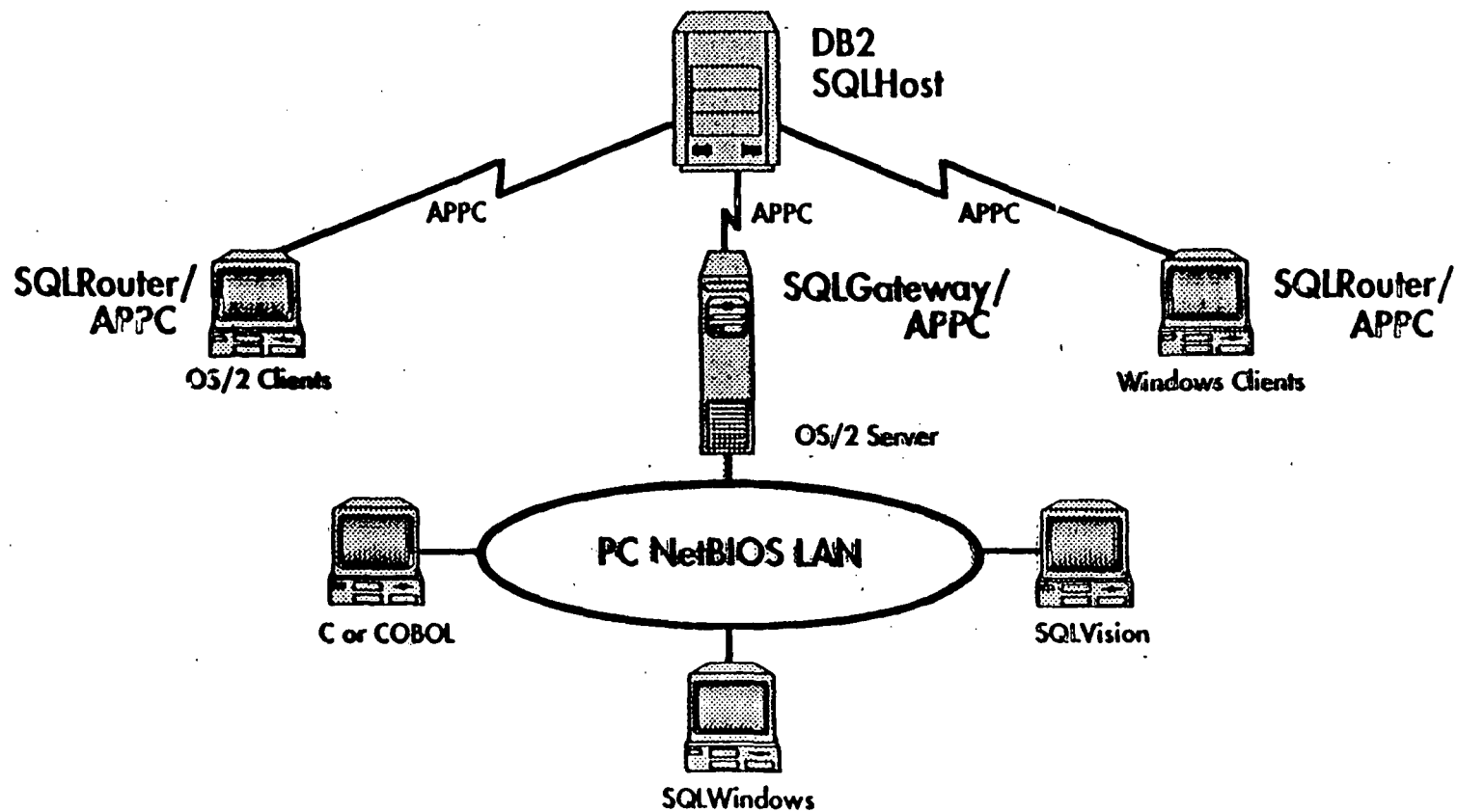
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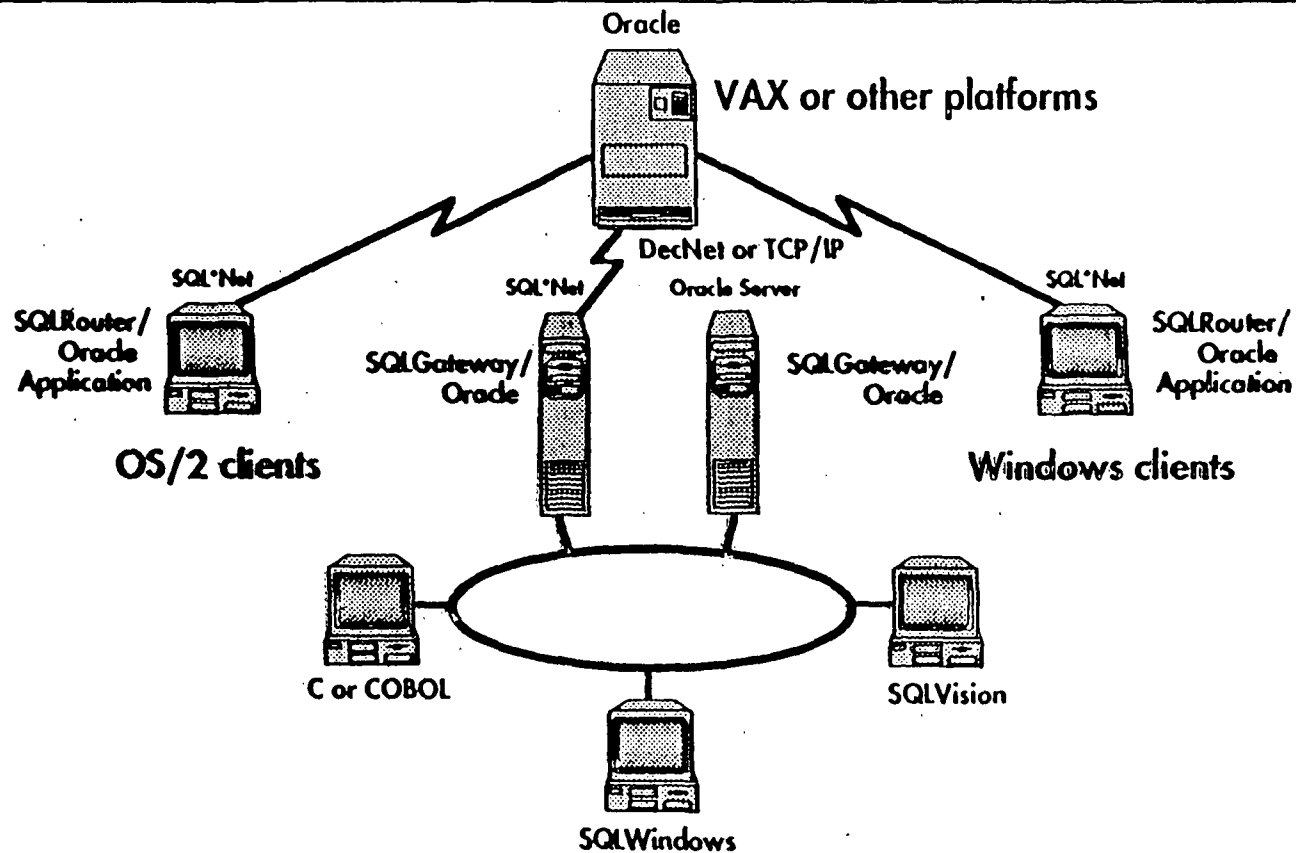
Gupta SQL System



PC to DB2 Connectivity with SQLNetwork



SQLNetwork for Oracle



Regional Multiple Listing Service

File Connect Query Display

Query

All

by City

by Property Number

by Price - Less

by Price - More

by Age - Newer

by Age - Older

City:

Broker:

Agent:

Listed:

Thru:

Property #:

Lot Size:

Bedrooms:

Baths:

Age:

Description:

Database/Query Status

DEMO

DB2DEMO

File Edit Outline Draw View Search
Run F1=Help

- ♦ Title: Estimate Prices
- ♦ Window Location and Size
- ♦ Visible? Yes
- ♦ Keyboard Accelerator: (none)
- ♦ Message Actions
 - ♦ On SAM Click
 - Set fldOurPrice = fldl IstPrice - 5000

Fast Car Auto Brokers

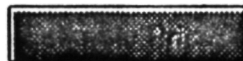
Form Edit

Make:

Model:

List Price:

Our Price:



SQLWindows - FASTCAR.APP

File Edit Outline Draw View

Search Run

F1=Help

- ♦ Form Window: frmMain
 - ♦ Title: Fast Car Auto Brokers
 - ♦ Icon File: (none)
 - ♦ Display Settings
 - ♦ Menu
 - ♦ Contents
 - ♦ Data Field: fldCarMake
 - ♦ Background Text: Ma&ke:
 - ♦ Background Text: &Model:
 - ♦ Data Field: fldModel
 - ♦ Background Text: &List Price:
 - ♦ Data Field: fldListPrice
 - ♦ Background Text: &Our Price:
 - ♦ Data Field: fldOurPrice
 - ♦ Data
 - ♦ Maximum Data Length: Dynamic
 - ♦ Data Type: Number
 - ♦ Editable? Yes
 - ♦ Display Settings
 - ♦ Window Location and Size
 - ♦ Visible? Yes
 - ♦ Border? Yes
 - ♦ Format: Currency
 - ♦ Country: Default
 - ♦ Message Actions

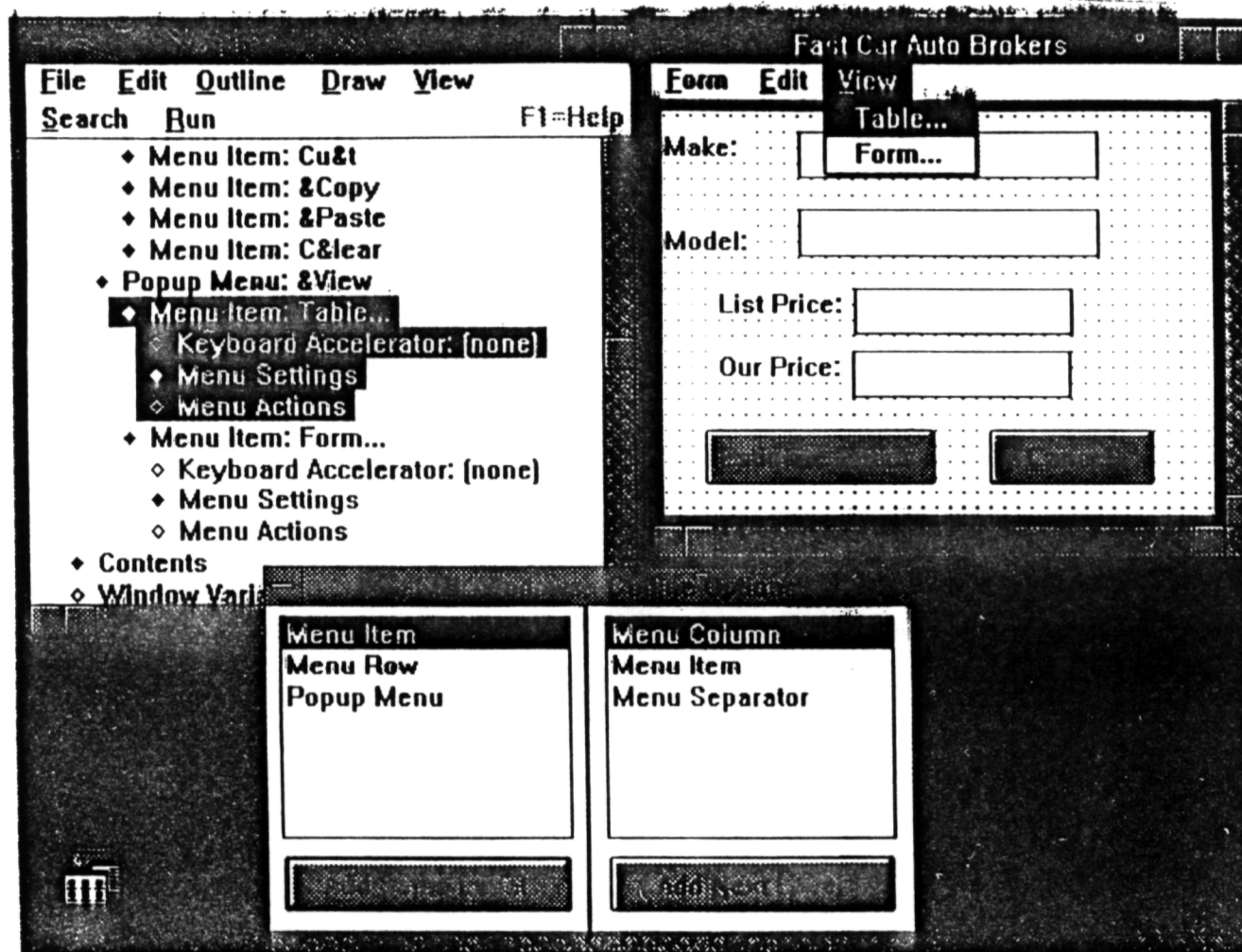
Form Edit

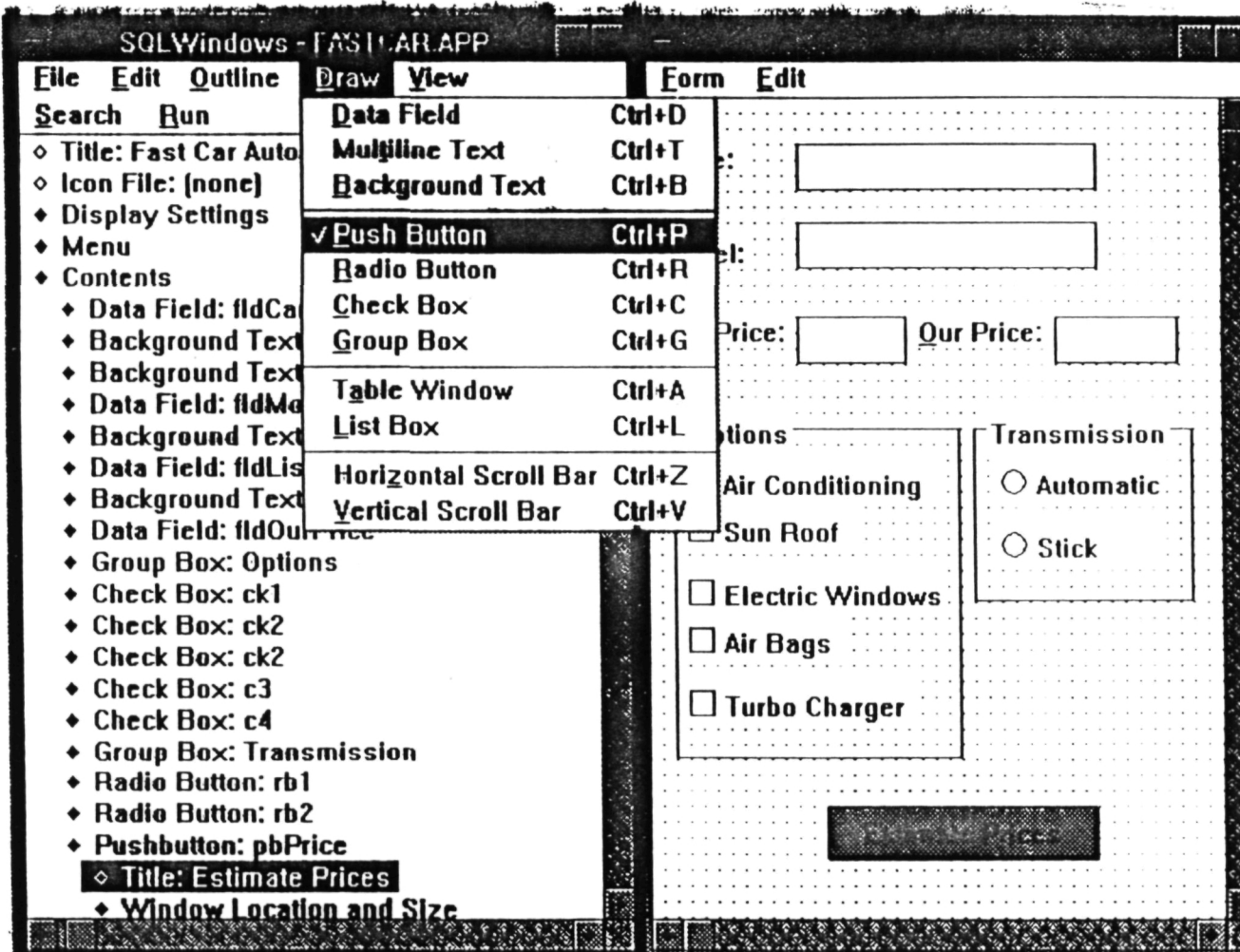
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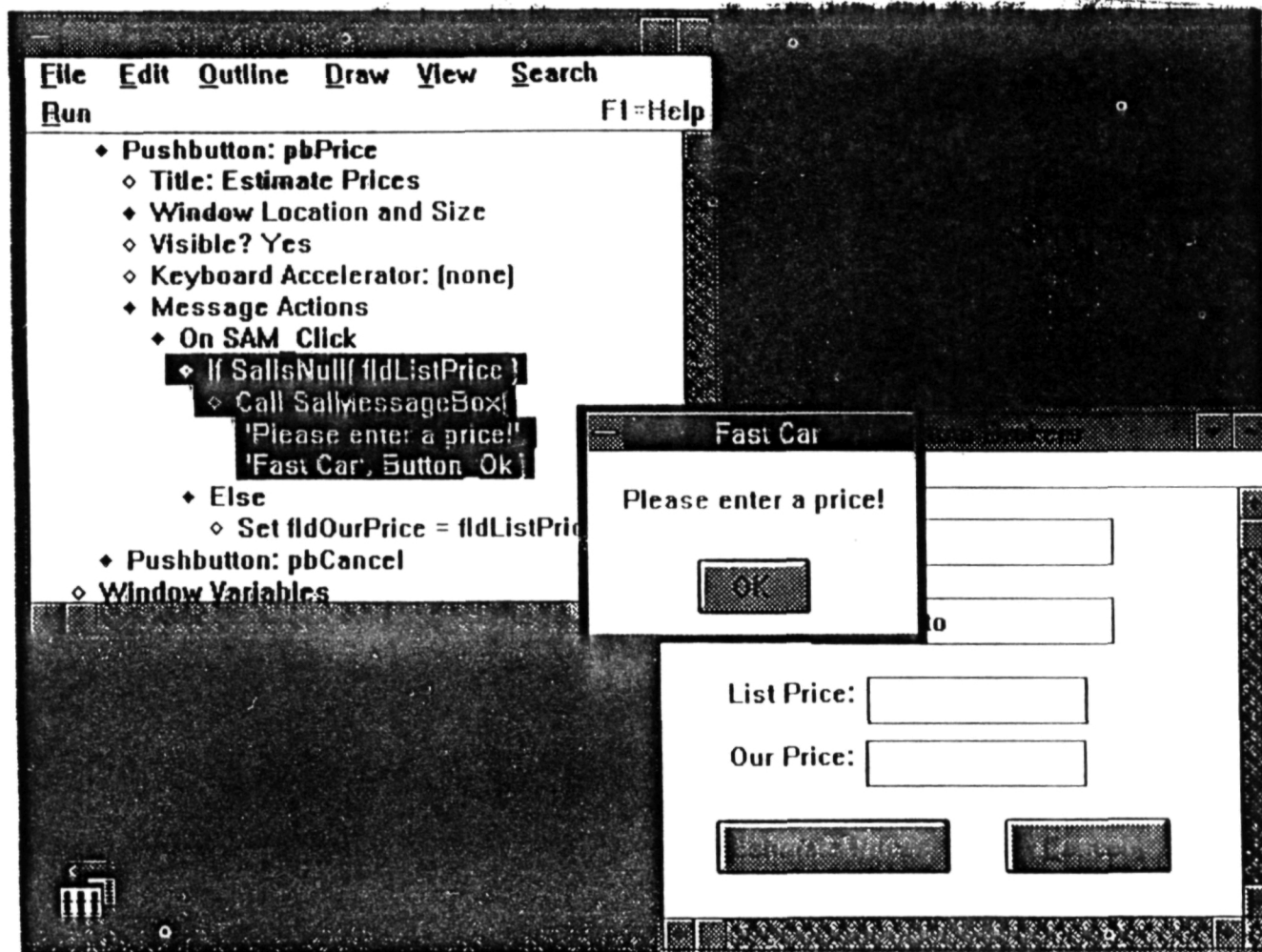
Model:

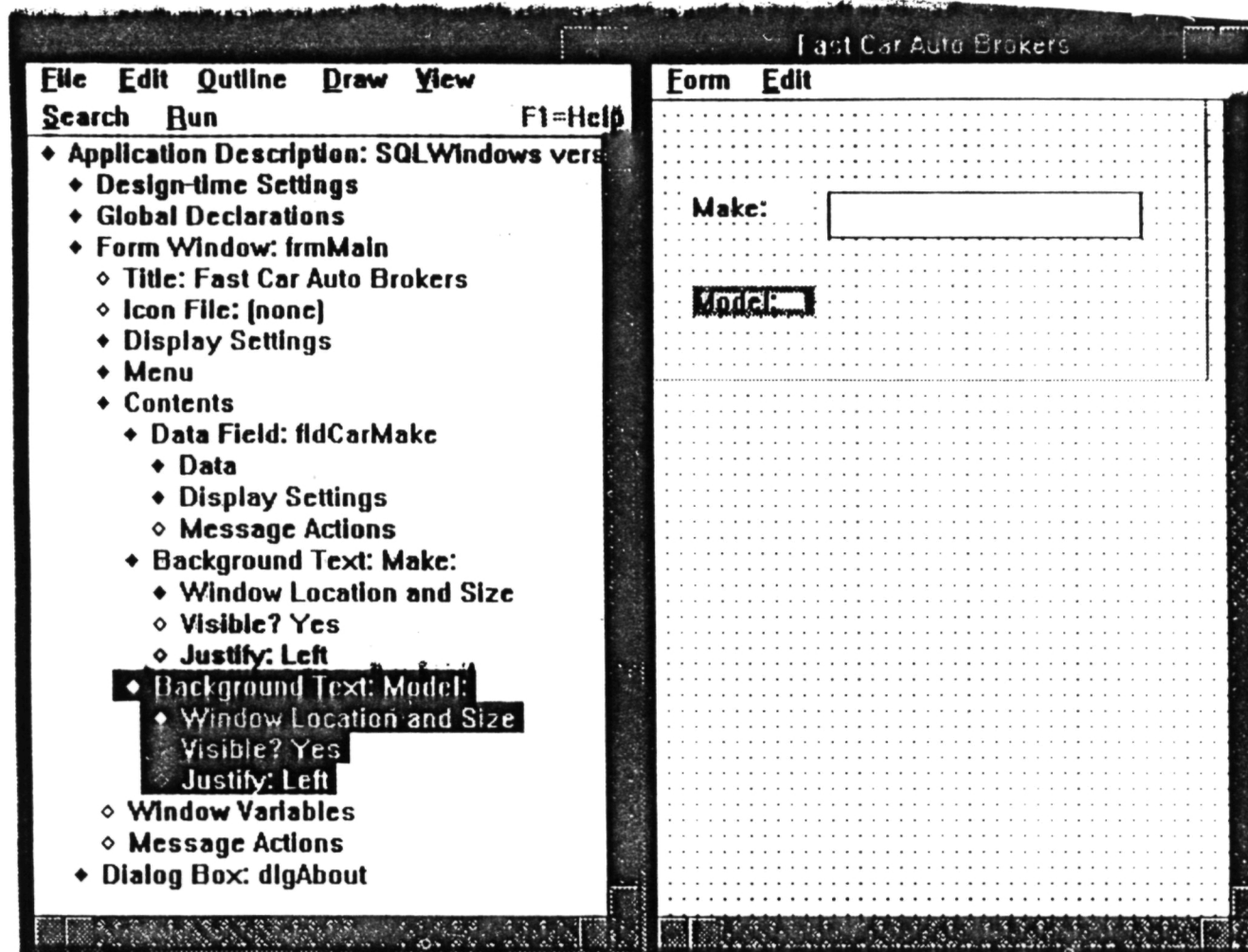
List Price:

Our Price:









Regional Multiple Listing Service

File Connect Query Database

City: Woodside

Area: Skyline

Property #: N24680

Asking Price: \$1,200,000.00

Lot Size: 40X85

Broker: Houlihan Lawrence

Bedrooms: 4

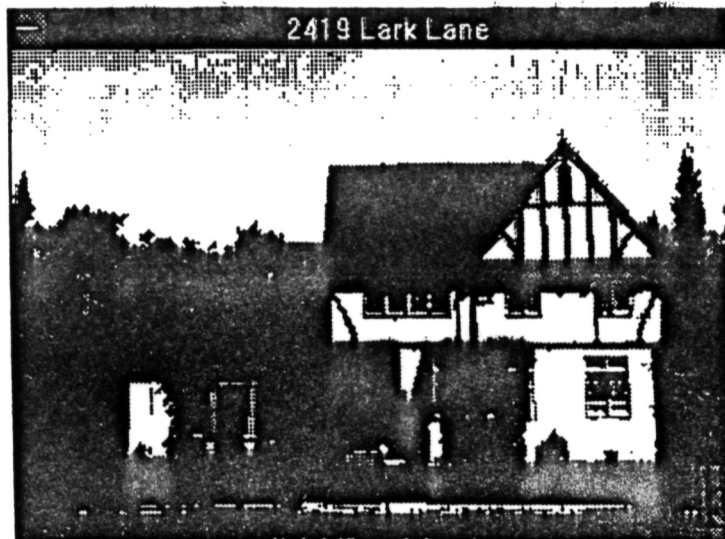
Agent: William Betts

Baths: 2

Listed: 10/14/88 Thru: 12/14/89

Description: Age: 20

English style Tudor of brick and stone set in park like surroundings. Designer kitchen, rec room, cozy living room with fireplace. Skylit master suite. Complete security system. Separate guest cottage/office.



Database/Query Status

DEMO
DB2DEMO



Session 5

Management Concerns in Networking Chair: Dennis Adams, *University of Houston*

N 9 2 - 1 2 5 0 6

Information Logistics

Dennis Adams, *University of Houston*

Abstract

Logistics can be defined as the process of strategically managing the acquisition, movement and storage of materials, parts and finished inventory (and the related information flows) through the organization and its marketing channels in a cost effective manner. It is concerned with delivering the right product, to the right customer, in the right place and at the right time. The logistics function is composed of inventory management, facilities management, communications unitization, transportation, materials management and production scheduling.

The relationship between logistics and information systems is clear. Systems such as Electronic Data Interchange (EDI), Point of Sale (POS) systems, and Just in Time (JIT) inventory management systems are important elements in the management of product development and delivery. With improved access to market demand figures, logisticians can decrease inventory sizes and better service customer demand. However, without accurate, timely information, little, if any, of this would be feasible in today's global markets.

Information systems specialists can learn from logisticians. In a manner similar to logistics management, *information logistics* is concerned with the delivery of the right data, to the right customer, at the right time. As such, information systems are integral components of the information logistics system charged with providing customers with accurate, timely, cost-effective and useful information.

Information logistics is a management style and composed of elements similar to those associated with the traditional logistics activity: inventory management (data resource management), facilities management (distributed, centralized and decentralized information systems), communications (participative design and joint application development methodologies), unitization (input/output system design, i.e., packaging or formatting of the information), transportation (voice, data, image and video communication systems), materials management (data acquisition, e.g., EDI, POS, external databases, data entry) and production scheduling (job, staff and project scheduling).

Information Logistics:

A Production-Line Approach to Information Services

Dennis A. Adams

Chee-Seng Lee

INTRODUCTION

Information has long been considered to be a service good, and information systems (IS) personnel perceived as providers of services that are essential not just for the daily operations but for long-term strategic needs. Whether for short-term or long-term needs, information is constantly being used to make decisions for financial, marketing, R&D and manufacturing needs. Information systems are thought of as service weapons that can be wielded to gain market share, excess profits, and thus improve profitability for the company that produces the most innovative information systems.

IS is no panacea. It is a tool for producing a resource-- information--that can be used to leverage or replace existing resources. By focusing upon the delivery of relevant, accurate and valid information, IS personnel will have engendered substantial strategic impact upon the growth of their firms. In other words, IS personnel should concentrate upon treating information, though an invaluable resource, as a product, deserving of quality-oriented techniques designed for manufactured products.

THE INFORMATION PRODUCT

Why has information been considered a service good? It might be instructive to consider the characteristics of services vis-a-vis products, and then consider where information might fall between the two categories.

Though it is true that all goods, when marketed, possess both service and product components, the focus here is upon the very nature of the good itself, and not its marketing. Thus a research report produced by a consultant is not the service being acquired by the customer; it is the analysis, synthesis and conclusion generated by the consultant while using that person's skills that is being purchased.

A key criterion in distinguishing a service good from a product good, is tangibility which forms the basis for other criteria such as perishability and simultaneity of production and consumption. However it can be demonstrated that information, though intangible, does not necessarily fulfill the remaining criteria for service goods.

Perishability

Service offerings are generally considered as being perishable in that service vendors cannot stockpile services that can be used to smooth demand fluctuations for their services. However, this criterion does not hold true for information. Information can be preserved in databases for many years and retrieved for use without the loss of any accuracy; though the electronic media may deteriorate, the information can be transferred to newer, fresher media. Thus, information need never perish. In this respect, information is similar to products. However, unlike material goods, information can be compressed or condensed and still retain its accuracy.

The capability of maintaining information from the moment of storage until usage enables the consumer to possess confidence in the quality of the stored information. Since the usefulness of information is dependent upon the consumer's perception, only the user can be the judge of the value of information stored in computer databases. Consequently, to the consumer, information can appreciate or depreciate in value. This characteristic is

unique to information because products typically depreciate with the passage of time, and services depreciate upon consumption.

Simultaneity of production and consumption

This criterion is linked to the foregoing concept in that the perishability of services necessitates that it be produced only when consumed. Though this criterion holds true for many services, information can be collected, stored, processed, and distributed even before there is a need for it. In fact, information can be consumed over and over.

Ownership

Information poses a unique problem regarding ownership. Like products, the ownership of information, can be established. On the other hand, information can be shared infinitely. Information that is shared does not result in loss ownership; in fact, every recipient of the information can legally or otherwise put it to use. There is no division or loss of ownership when information is transmitted. Unlike products where ownership changes hands or services where the service potential remains with the owner. Thus we postulate that information can be perceived as a hybrid product/service. With these qualities, information is far more amenable to the concept of service industrialization.

INFORMATION LOGISTICS

Logistics can be defined as the process of strategically managing the acquisition, movement and storage of materials, parts and finished inventory (and the related information flows) through the organization and its marketing channels in a cost effective manner. It is concerned with delivering the right product, to the right customer, in the right

place and at the right time. The logistics function is composed of inventory management, facilities management, communications, unitization, transportation, materials management and production scheduling.

The roots of logistics management are deep. However, the renewed interest in the area began in the early 1970s. Deregulation and improved information systems served to create opportunities and threats in markets that once competed in geographically small areas. The ability to penetrate new markets, at home and abroad, pointed up problems in existing logistics systems. When energy prices and interest rates began to climb, the costs of inventory and transportation became significant portions of the organization's bottom line. Logistics managers were called upon to manage more than trucks and inventories; they needed to manage the entire process. Having the right information to do this was essential.

The relationship between logistics and information systems is clear. Electronic Data Interchange (EDI), Point of Sale (POS) systems, and Just in Time (JIT) inventory management systems are important elements in the management of product development and delivery. With improved access to market demand figures, logisticians can decrease inventory sizes and better service customer demand. However, without accurate, timely information, little, if any, of this would be feasible in today's global markets.

Information systems specialists can learn from logisticians. In a manner similar to logistics management, information logistics is concerned with the delivery of the right data, to the right customer, at the right time. As such, information systems are integral components of the information logistics system charged with providing customers with accurate, timely, cost-effective and useful information.

Information logistics is composed of elements similar to those associated with the traditional logistics activity: inventory management (data resource management), facilities management (distributed, centralized and decentralized information systems), communications (participative design and joint application development methodologies), unitization (input/output system design, i.e. the packaging or forming of the information), transportation (voice, data, image and video communication systems), materials management (data acquisition, e.g., EDI, POS, external databases, data entry) and production scheduling (job, staff and project scheduling).

There is a strong association between the rise of the IS consultancy and information logistics. As information system users become more sophisticated and as IS outsourcers become more adept at providing information services to clients, the traditional IS department becomes more an information technology consultant than a supplier of information system products. However, the management of the information inventory and delivery systems will remain a service provided by the IS consultant. Information logistics is the foundation of this concept.

INDUSTRIALIZATION OF INFORMATION SERVICES

Leavitt's purpose in introducing the concept of service industrialization was to improve the efficiency and consistency of delivered offerings of service industries. He points out that traditional manufacturing industries have been able to introduce mass-production techniques that allowed for the cost-efficient manufacturing of goods at a consistent level of quality. The productivity increases in industrial processes result from the transformation of the manufacturing methods, or the manufacturing tasks themselves.

On the other hand, productivity increases in the service industries fall upon the shoulders of the performers of those desired services. Leavitt maintains that service companies "fail to think and act as do manufacturing companies concerned with the efficient, low-cost production of consumer-satisfying products." His suggestion is that the same concepts that have proved so successful for manufacturing industries (standardization and automation) could be introduced to the service industries.

Leavitt's ideas are well suited to the field of information systems. Such innovations include the use of computer-aided software engineering (CASE) for software development and maintenance, and the introduction of object-oriented programming (OOP) for reusable software modules.

In the past, the production of computer software has been performed using pencil and paper. The inefficiency of the traditional methods of software development has been compared to using a stone knife to build jet fighter. It is no wonder that a recent survey of IS projects reveal that 79% are behind schedule, 19% are on schedule, and a minuscule 2% are ahead of schedule. The average effort is 235 person-months, and each project is estimated to be useful for only 20.7 months. Furthermore, up to 25% of projects involving more than 60,000 lines of code are cancelled before completion.

Such is the waste of traditional software development methods that treat information as a service, and the development of information systems as a craft. How can top management rely on an unsound approach to information systems development devoting millions of dollars to projects that would be unthinkable on the factory floor?

CASE tools and structured systems development methodologies, that are being used to automate the software process, are functionally equivalent to the automated equipment used in the manufacture of products. With the use of these tools and other related

innovations to automate the production and maintenance of software, companies can methodically approach the strategic potential of information by quickly creating quality-oriented products.

The object-oriented approach allows software and information to be used and reused in the construction of new software. Program code for routine tasks has traditionally been rewritten each time it is needed. This creates labor inefficiencies. The idea of "plug-and-play" software components allows software developers to use existing software components to create new information systems and to innovate by using previously created software components.

The use of CASE tools for standardized software development and maintenance, and the use of OOP techniques for the creation and reuse of software components is partially the consequence of the production-line approach to information systems development. But how will the production-line approach to information be of use to management? Will companies gain any new insights to using information systems for strategic advantage? How will information as a product be put to better use than information as a service?

Treating information as a product during the acquisition, storage, processing and distribution stages of its value chain renders it amenable to a manufacturing approach that would provide for its improved production efficiency, quality and responsiveness. Thus, it would be instructive to examine the manufacturing process as applied to the production of tangible items. One manufacturing concept that has proven highly successful and effective in increasing manufacturers' responsiveness and profits is flexible manufacturing. Flexible manufacturing is based upon the integration of computer-aided design and computer-aided manufacturing (CAD/CAM), sometimes collectively termed computer integrated manufacturing (CIM), that provides for the speedy design and manufacture of small job

runs.

A flexible manufacturing approach to the development and implementation of the software components of information systems will allow for the development of more responsive information products. Merrill Lynch would not have held such an overwhelming share of the cash-management account marketplace but for the lack of quick response by its competitors. If the information system departments of competing firms had been able to develop similar financial products very quickly, Merrill Lynch would not have been acclaimed a leader in the strategic use of information systems.

By applying the flexible manufacturing approach in generating information products, information systems personnel would be able to enhance their firm's abilities to respond to external competitive pressures. Just as speed is crucial in responding to competition, information is crucial in attaining responsiveness.

A PRODUCTION-SERVICE MODEL OF INFORMATION SERVICES

We postulate that it is important to divorce information from the production process itself--the information system--because the strategic value arises from the information, and not the information system. Only by doing this can management focus upon the value-added impact of information, and not the technology used to produce it.

The user has several options that are available for the processing and presentation of the data, and may be indifferent as to how it is delivered. Just as the consumer of virtually any manufactured good does not know or care much about the production intricacies associated with that product, the consumer of information is usually not concerned with its production by the information system. As long as the information is

delivered in an accurate and timely fashion, organizations have shown that they are not concerned with who is actually involved as long as proper controls are maintained. Companies such as Enron and Kodak have demonstrated that data processing activities can be managed by third party "outsourcers" and not disrupt information flow. (It is not clear, however, what the long-term, strategic impact of these agreements will be.)

Porter uses the idea of a value chain to present the notion that, as raw materials move through the organization's transformation process, they gain value. Different elements of the organization support or add value to these products. Porter suggests the information systems role is one of these support functions. However, it is useful to apply the value chain to the information systems function itself, as can be seen in Exhibit 1.

This value chain is partitioned into information production and information services. *Information production* is concerned with the acquisition, storage, processing and distribution of information, while *information services* provides marketing and consulting functions.

The *information production* function roughly corresponds with what is traditionally thought of as a data processing operation. **Inbound logistics** contains those actions that acquire data from sources external to information systems. These "raw materials" might come from Electronic Data Interchange documents, Electronic Funds Transfers, Point-of-Sale systems or more traditional data entry systems. This data is collected and stored in a data inventory for processing.

The **operations function** transforms the data inventory into usable forms. The systems development life cycle is a structured procedure that creates the transformation process. Object oriented programming is a new technique that treats pieces of programs and data as component parts that can be used and reused in new systems. This flexible manufacturing approach to information production has the potential of greatly changing the

way systems are constructed. CASE tools are akin to robotics and factory automation in that they can be used to automate the production of the information system and the information.

Outbound logistics is associated with the delivery of the information to the consumer. Information communication systems can deliver voice, data, image or video information to and from the consumer. The outbound logistics function is the focal management point in a distributed data processing environment where the multiple, distributed data inventory warehouses pose logistical problems. A variety of connectivity, distributed database and cooperative processing tools are emerging to address this situation.

The *information production* function can be managed as a flexible job-shop manufacturing operation. As such, all systems are developed essentially alike and are constructed of the same basic components. Using reusable objects and CASE tools, information system products can be quickly developed and delivered. The application portfolio would consist not of programs, but of programming objects that can be manipulated by CASE tools. A production line of object specialists can install various components of the overall system under the supervision of a line manager--the traditional systems analyst.

This internal view of information management is contrasted with the service-oriented external view held by the rest of the organization. *Information services* provides all of the consumer relations services normally found in other functional areas. This area is charged with the duty of identifying and satisfying consumer demand for information. **Information services marketing** embodies the information consultancy function. This function acts as an information technology consulting and planning team for the organization. Because information consumers have a number of sources for information processing, this marketing

function is concerned with consumer relations and information services marketing. It may seem odd to market a service whose demand is far greater than its supply. However, as the numbers of departmental systems grow and as users become more sophisticated in their own data processing abilities, the demand for information services will change.

Information system services aids users in the consumption of information. The information center and help desk/hotline functions will not only enable consumers to better avail themselves of the information, but will also be a key component of the consumer relations staff possibly affecting future demand for services.

By dividing the information systems function into a product component and a services component, the correct emphasis may be placed on each. To the consumer, IS is viewed as a service organization ready to fill an information need. Internally, it is viewed as a flexible manufacturer of information transformation tools, a data warehouser and a common carrier of information goods, with emphasis on cost control, application object portfolio management and quality control (just-in-time data inventory practices and Jidoka-quality at the source--data acquisition and systems design). In so doing, there are several implications for the CIO and other chief executives.

ISSUES FOR THE CIO

Users have other sources for information support. Managers of information systems are increasingly aware of the data processing capabilities that are accumulating in the users' hands. Another trend facing these managers is that of outsourcing of the data processing function. Outsourcing occurs when an outside party contracts to provide some or all of an organization's information processing needs for a period of time. Firms such as Andersen Consulting, EDS and IBM are taking over data center operations, systems development

projects and IS strategic planning. Firms that have chosen to outsource primarily do so to cut costs.

In some cases, this represents a threat to inhouse staff. An information production approach that focuses on cost control and consistently high quality products can not only make the operations function run more smoothly, but can serve to improve consumer relations and overall IS productivity.

The information systems function is an information transporter, transformer and warehouser. It is essential for the IS staff to realize that systems and data with which they work represent valuable corporate resources. In the past, this has been a good idea that has been difficult to operationalize. A database can be considered to be a data inventory stored in an information warehouse; the information communication system can be a common carrier; systems development tools are like flexible factory automation cells.

Adopting this attitude toward information systems would be helpful in creating a manufacturing atmosphere for the production of information systems. Managers can apply production and logistics techniques to the function and can concentrate on efficiencies and portfolio management.

Building the object portfolio will take time. As new projects are evaluated for consideration, the constituent objects, new and existing, should be evaluated. The new objects should be weighed for future use and remarketing. As systems grow, mature and decline unless they are re-engineered and begin to mature again. The object oriented approach would make this re-engineering effort more effective.

The information systems function can be run as a business unit. The information systems function can be thought of as a business unit just as any other area. This is not new, but costs can be better controlled. The information production concept allows

managers to concentrate, internally, on cost control, thoughtful resource allocation and quality assurance. The information service approach gives managers the opportunity to focus on "profit" or "sales". This balance is critical to the overall success of the information production services approach.

Emphasize functional marketing and product delivery. Support of functional business areas will allow the IS group to more successfully market information technologies. Systems analyst sales representatives should be assigned to specific functional areas in an attempt to better understand the decision making environment in which their customers exist. By acting as information systems consultants, these individuals will be able to direct and enhance the use of information technologies within those areas by looking for opportunities to diversify the application portfolio in support of the functional business unit's goals.

The concentration on product delivery will emphasize the desire on the part of the IS business unit of the importance of customer satisfaction and product quality. Many organizations already have systems analyst-business specialists that become knowledgeable in the functional area in which they are assigned. These individuals, however, rarely have responsibility for the ultimate satisfaction of the information consumers, but act more like consultants to the IS staff for correct system design.

ISSUES FOR OTHER CHIEF EXECUTIVES

Choose appropriate IS purchase strategy. There are a variety of sources of information technologies. Business units can choose the purchase strategy that exhibits the amount of control desired. For example, some managers want ultimate control over the processing of the information on which they base their decisions. As such, these managers elect to establish an information systems staff within the functional area. Other managers wish to

relinquish some of their control and select a more centralized information processing alternative. Still others choose to outsource to satisfy their information needs. The amount of control desired is a function of the individual's management style, the relative costs associated with the project, organizational imperatives and personalities, and the level of technological expertise required to manage the task.

The information systems function is a seller, a marketer, a provider--the information is a corporate resource. The information technology staff is internally operated as a manufacturing concern that produces information transformation and delivery products. The information that passes through those systems is a corporate resource that can be manipulated in a variety of ways. As a manufacturer, IS will focus on product alignment and development strategies that will serve to lower overall costs to the organization. It is necessary to separate the information from the information system when selecting an information technology provider.

IS will evaluate projects as to their fit with the portfolio and production line. As with all manufacturing operations, the production line, once configured, can produce only certain goods. It must be retooled before it can produce different products. Even in the flexible manufacturing environment, there is a setup cost associated with new products. The IS staff will view all new projects as potential alterations to its production facilities and will encourage solutions that use existing portfolio products.

Competitive uses of information technologies are championed by the functional areas. As can be seen in many case studies, the IS function typically does not suggest competitive applications of information technology, but instead, offers technological solutions to functional problems. This implies that IS and non-IS management teams must understand each other's concerns and strengths. The IS consultancy will scan the technological

environment and, when discussing functional problems and desires, present potential solutions. Without this interaction, however, the functional manager will have to scan the IS environment as well as his or her own environment to successfully apply information technology. Also, if IS suggests solutions to functional concerns, the wrong problem may be solved or resources needlessly spent.

SUMMARY

The creation of information products has traditionally been viewed as an art or craft, not amenable to rapid, mass production. The service approach to this area has caused significant backlogs and cost overruns. For decades, the limitations of the information technology itself prohibited the efficient production of information and information systems. However, with tools such as computer aided software engineering and object oriented programming, many of the advantages of flexible manufacturing found on the factory floor can be transferred to the software shop. The result should be the rapid creation of information delivery systems that respond to the needs of the information consumers. Also, by using components from previously manufactured systems that have been time tested and intelligent object management practices, the quality of these systems should be at least as high as their constituent components. By separating information from the information system development process and treating systems as products can help organizations more effectively combat the use of other information technologies as competitive weapons, or can protect advantages previously gained by these systems.

I T
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INFORMATION PRODUCTION				INFORMATION SERVICES	
In Bound Logistics	Operations	Out Bound Logistics		Sales & Marketing	System Services
Data Entry Data Capture (Electronic Data, Interchange, Point-of-Sale, Electronic Funds Transfers, etc.)	Systems Development Life Cycle Tools: Object Oriented Programming and Databases, Computer Aided Software Engineering, etc.	Information Communications (Voice, Data, Video, Image, etc.)		IS Consultancy Marketing of IS Information Consumer Relations	Information Centers Help Desks/ Hot Lines Maintenance Training

Exhibit 1: Production/Service Model for Information Systems

A Definition of Traditional Logistics

The process of strategically managing the acquisition, movement and storage of materials, parts and finished inventory (and the related information flows) through the organization and its marketing channel in such a way that current and future profitability is maximized through the cost-effective fulfillment of orders (Gattorna, 1988)

Traditional Logistic Elements

Transportation

Storage

Quantity to be distributed to
consumers

Technological content of the
product

Product reliability

Replacement time for additional
spare or repair parts

Test and Support Equipment

Documentation

Personnel and Training

Spares and Repair Parts

Traditional Logistic Elements

Facilities

Supplier storage

Incoming materials storage

Finished goods storage

Production equipment

 maintenance facilities

Maintenance and repair

 facilities after transfer of
 ownership

A Definition of Information Logistics

Information logistics is the process of strategically managing the acquisition, movement and storage of information. It is the delivery of the right information to the right person at the right time in the right format.

Information Logistics

Information Logistics is a
Process

Top Management Support is
Critical

It is the Acquisition,
Movement and Storage of
Information

Information Logistics

Information Logistics is the
delivery of:

The Right Information

The Right Person

The Right Time

The Right Format

Information Logistics Elements

Transportation - Technical
and Organizational
Communication Structures

Storage - Database Systems

Spare and Repair Parts -
Fault Tolerant Systems and
Structures

Personnel and Training

Information Logistics Elements

Documentation -
Organizational and
Technical

Test and Support Equipment -
Diagnostic Systems

Facilities - Data Collection
and Presentation Systems

The Nature of Information

Information is Infinitely
Sharable

Ownership is a Function of
Evaluation

Its Value is not Fixed

Information Need Never Perish

A Production/Service Model of Information Logistics

	INFORMATION PRODUCTION			INFORMATION SERVICES	
	In Bound Logistics	Operations	Out Bound Logistics	Sales & Marketing	System Services
I T	Data Entry	Systems	Information	IS	Information
n e E	Data Capture	Development	Communications	Consultancy	Centers
f c x	(Electronic Data,	Life Cycle	(Voice, Data,	Marketing	Help Desks/
o h a	Interchange,	Tools: Object	Video, Image,	of IS	Hot Lines
r n m	Point-of-Sale,	Oriented	etc.)	Information	Maintenance
m o p	Electronic Funds	Programming and		Consumer	Training
a l l	Transfers, etc.)	Databases, Computer		Relations	
t o e		Aided Software			
i g s		Engineering, etc.			
o y					
n					

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The Business Case for Connectivity
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Abstract

Information systems that provide competitive advantages to organizations can be broadly classified into those that improve the effectiveness of a business function and those that improve the reach of information in the organization. The latter, organizational connectivity systems, can be categorized as intra-organizational and interorganizational systems. Intraorganizational systems provide connectivity to functional areas within the business, while interorganizational systems support the exchange of business data between independent business units. These systems are not confined to a single entity but span organizational boundaries which can be national or international in scope.

A series of case studies was undertaken in an effort to better understand the issues and problems associated with providing an increased flow of information within and outside of an organization. Ten issues emerged from this study. In summary, it is necessary for firms to first consider how effective their internal communications systems are before launching projects that tie the organization to external systems.

The Business Case for Connectivity

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THE BUSINESS CASE FOR CONNECTIVITY

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INTRODUCTION

Information systems that provide competitive advantages can be broadly classified into those that improve the effectiveness of a business function and those that improve the reach of information in the organization. Examples of the former include American Express' credit authorization system, Authorizer's Assistant, and United Services Automobile Association's call distribution and document imaging system embodied in their Vision 2000 plan. The advantage gained through these applications is a result of automating (or simply codifying) human expertise. Advantages of this type are most difficult for a competitor to neutralize if this expertise is rare.

The well known examples of the latter include General Motor's EDI system, American Hospital Supply's ASAP system and American Airlines' SABRE reservation system. These competitive applications often have one thing in common: they are interorganizational systems that involve linking one or more companies together. This connectivity is a difficult issue because the mere interconnection of communication systems can be costly and inherently provides no advantage to anyone. In

addition, advantages gained by the interconnection of systems can be easily copied if there are no economies of scale advantages attained by early adopters. One may well ask whether these connectivity applications are worth the effort.

The purpose of this paper is to discuss the business case for connectivity. Because so many of the successful uses of information systems for competitive advantage incorporate communication systems, it is worthwhile to understand the capabilities, issues and prospects associated with this strategy.

CONNECTIVITY

Connectivity can be defined as the effective joining of two systems for the purpose of resource sharing. This definition can be interpreted in several ways. For example, to the user, a successful connectivity application would be one where the user does not know or care where the data is stored, where it is processed or how it is transported. To the application programmer, connectivity might be implemented by the use of standard compilers or common network interfaces or data formats. The systems programmer is concerned with the transportability of operating systems while the data communications specialist worries about the compatibilities of various network protocols. To the manager, connectivity implies multiple platform access to corporate information resources and confidence that future software and equipment purchases will disrupt organizational

information processing as little as possible--that functionality drives purchase rather than the reverse.

As can be seen, the operationalization of connectivity encompasses many aspects of information systems. In addition, connectivity is a matter of degree. All systems are "connectable"; the purchaser must decide whether the connection is worth the expense and the designer must ascertain whether the effort is worth the connection. Some elements of the information systems architecture have higher connectivity "payoffs" than others. For example, selecting a common network protocol (say, X.25) may be easier than writing software to convert machine instructions from different architectures. On the other hand, if a network protocol is already in place, developing multiarchitecture applications using a common user interface may be more appealing.

Connectivity can be accomplished from various points of view. More specifically, connectivity can be thought of as a function of operating systems and system environments, connectivity applications such as file transfer methods, user interfaces, programming languages, network protocols, data formats and physical connections. These various connectivity strategies have evolved through five phases. First, telephone and telegraph systems provided organizational connectivity that forever changed the way business was conducted and the relationships between workers, consumers and producers. The second phase, circa 1965, focused on providing connections

between similar, typically mainframe, systems within a single organization. Next, as firms began acquiring more information processing equipment, attention turned to connecting dissimilar, yet centrally located systems, still within a single organization. As the price of computing hardware began to fall in the late 1970s, providing connections between distributed, possibly heterogeneous systems was needed. Proprietary and nonproprietary connectivity solutions began appearing and users became more aware of the need for improved, serviceable access to data. The explosive growth of the personal workstation in the early 1980s exacerbated the problem. For many organizations, this represents their state of connectivity. However, the interorganizational sharing of data is a phase of connectivity that will dramatically change the way in which organizations collect and process data. Electronic Funds Transfer (EFT) and Electronic Data Interchange (EDI) are important examples of interorganizational information sharing. The fifth phase of connectivity solutions can be termed "Information Logistics".

Information logistics is more a concept than a product. The basic tenet is that of information delivery--to deliver the right information in the right format to the right decision maker at the right time. Conversely, the decision maker need not know where the data is stored, how it is transmitted, how to format it for use, or how much effort it will take to acquire it. The focus of information logistics is not how to delivery the data, but how to best deliver the data. Traditional data

communications systems simply provide a conduit between the user and the application. This view is much too narrow to effectively incorporate interorganizational systems into the information systems portfolio because the very interaction has been elevated to a competitive level that requires more than moving data from one place to another. In fact, each data element stored in an organization's information systems, from the viewpoint of information logistics, would be associated with the set of potential users (as opposed to uses) of that information and would be managed accordingly. There is no limitation concerning who these users are or where they will be when they use the data or even to what purpose the data will be put.

As organizations move toward the information logistics phase, connectivity solutions will become more complicated as they become more important. Of course, the issue of connectivity has been a problem confronting organizations for decades, and is clearly not confined to interorganizational systems. Organizations have been struggling to get various pieces of hardware and software to talk to one another since computers were first introduced. The problem is just exacerbated when the linkage has to extend across organizational boundaries. But the rewards of successful connectivity are legendary.

CONNECTIVITY TYPES

Organizational connectivity systems can be broadly categorized as intraorganizational and interorganizational

systems. Intraorganizational systems provide connectivity to functional areas within the business. These applications can provide new, cross-functional information to decision makers. From electronic mail to document imaging systems, the increased flow of information increases management's awareness of organizational activity.

Interorganizational systems support the exchange of business data between independent business units. These systems are not confined to a single entity but span organizational boundaries which can be national or international in scope. These boundaries can be arbitrary. In a conglomerate, systems that span the organizational chart can be thought of as interorganizational even though they reside within a single parent company. The popular corporate sponsored credit card is an example of interorganizational systems that span industries. For example, earning American Airlines frequent flyer mileage by using a Citibank credit card.

Interestingly, when an interorganizational system is implemented, it is in reality a cross-functional system (or a set of systems) that spans organizational boundaries. Consequently, the distinction between intraorganizational and interorganizational systems is not as clear as it might be, because as cross-functional systems that span organizational boundaries become more common, it may not be at all clear which part of the system (or what portion of the data) is internal or external. In addition, some intraorganization, cross-functional

systems are international. Texas Instruments is an example. The design of a computer chip can be produced in Japan and electronically shipped to Lubbock, Texas where the components are manufactured. This product is shipped to Malaysia for testing and integration. The status of the design, manufacture, shipping, testing and customer delivery are maintained in a database accessible throughout the organization. It is expected that as more TI customers and suppliers build EDI systems, the EDI transactions will also be reflected in this enormous cross functional system.

CASE STUDIES

Because of the desire to understand more about the issue of connectivity, the University of Houston's Information Systems Research Center sponsored a series of case studies to support ongoing research in the area of organizational connectivity. Eight large firms with operations scattered around the globe agreed to participate. In each case, managers familiar with the strategy and operation of the information and communications systems were interviewed in an attempt to understand the hardware, software and organizational systems involved in the intraorganizational and interorganizational systems. The findings of this investigation were compared with the experiences of a number of well known connectivity solutions such as American Hospital Supply's ASAP and Xerox's integrated manufacturing and office systems.

Of course, numerous other examples exist where the use of telecommunications was critical for the development of strategic systems, but what is often glossed over in such descriptions, is the substantial technical problems associated with connecting the disparate technologies together. The linking of such widely different technologies as personal computers, telephones, and phototypesetters, has proven to be difficult, but not impossible. While the costs associated with connectivity are generally high, the benefits can be quite astonishing. Those organizations who are successful in connecting the myriad of information technologies together and using them in meaningful applications, stand a good chance of obtaining (and retaining) a competitive edge. Therefore, it becomes clear that the business case for connectivity is "doing business better". Whether that means in a less costly fashion, doing it differently and distinguishing oneself, or distributing better information throughout the organization and giving employees and management a chance to do their jobs better, the bottom line is connectivity makes good business sense.

Connectivity is a broad issue. It has proven to be a complex issue: one which virtually every organization has to come to grips with, yet one whose resolution is highly elusive. It involves more than simply connecting bits of technology together. Connectivity is showing itself to be a strategic issue, one which can only be ignored at an organization's peril. Moreover, it is more than just intraorganizational systems. Much

of the future appears to lie in interorganizational systems, and for these to become a reality, the issue of connectivity has to be resolved. Organizations will simply not be able to effectively compete with those who successfully employ systems which span their customers and suppliers. These interorganizational systems will become the lifeblood for organizational competitiveness. What emerged from this investigation was ten truisms or lessons that may be applied elsewhere.

LESSONS LEARNED

There are a number of lessons learned which emerge from these connectivity-related cases. Some are fairly obvious, such as the need for senior management support, others are more serendipitous. Many of the more interesting ones arise from interorganizational data exchange arising from EDI and are discussed in the first five points below. The next six points relate to connectivity in a more general sense, and we attempt to suggest how these lessons might be used in the development of an organizational connectivity strategy.

Penetration of Connectivity into Business Processes. The combined effect of decreased costs to provide organizational connectivity and the increasing capabilities of the computer systems to process the data internally, appears to result in a broader range of applications. The prevention of redundant encoding of data makes information readily accessible, and the

savings of time and money favor intra- and interorganizational data exchange.

Formal Cost/Benefit Analysis is not Done. Most connectivity applications are not justified in the traditional cost/benefit fashion as hard dollar figures are hard to come by. For example, most organizations implement EDI because it is perceived as a strategic necessity. Environmental forces and strategic motivation made EDI a must for the organization. For example, joint interest billing in the oil industry was developed because oil drilling is done by a consortium of oil companies since it is too expensive for any one company to drill all of its own wells. Because this is a group venture, there is a need to apportion costs to the appropriate oil company partners. Joint interest billing is this apportioning and involves the lead partner in the consortium sending out monthly itemized billing statement listing each partner's costs for that particular well. It is reported that this activity which traditionally took hundreds of hours per week, takes only minutes with EDI. What makes this EDI application all the more interesting, is the fact that the participants are all fierce competitors forced to trust one another in order to gain the common economic benefits from EDI. All participating organizations realized the value of cooperation through EDI; there was little need to perform a formal justification.

Connectivity as a Vehicle for Rethinking Business Functions.

With connectivity systems, starts a new analysis for business

opportunities, which can result in the connection of new functions. More generally, this communication has the potential to permeate the whole organizational domain, with the potential to connect many internal information flows; for example integrating EDI with just-in-time inventory scheduling. Finally, a continued analysis of information flows could help to uncover not just what does flow, but what could flow. It could open the opportunity for a new type of communication that deals with process improvements rather than with solving problems to improve processes. This clearly is seen to be true in the joint interest billing case where the participating oil companies see opportunities for new communication afforded through EDI.

Competitive Advantage through Connectivity. In the strategic arena, the benefits of connectivity are most visible in the improved perceived effectiveness by the end customer, whose requests can be complied with in a predictable and fast manner. Potential increases in market share can then help to sustain or even increase the competitive advantage. In this way, the connection can alter the bargaining power among buyers and suppliers.

As business competition continues to intensify, more and more companies are concentrating on their core competencies; this leaves open the possibility of a migration of functions to a supporting supplier company. Connection-oriented systems appear as an essential ingredient for the successful coordination of these new tasks.

Connectivity Involves Supporting Human Communication.

Contrary, perhaps, to expectation, connectivity is more effectively conceived as the means of supporting human communication not computer communication. While the latter is the focus of so much attention, it must not be forgotten that its *raison d'etre* is in support of the former. Computer communication exists to support human communication. Thus, an organization needs to consider the efficacy of its internal communication system: how well do people interact, how easy is it for them to interact, what procedures interfere with this interaction, how can the interactions be effectively supported, and so on.

It appears that no matter how good the computer connectivity is, it will have little real affect unless the human systems which it supports are working well. The old adage of: "computerization cannot help an organization that does not have its manual systems in order", appears doubly appropriate in the case of connectivity. So the first step in any strategy on connectivity is to critically analyze the organization's human communication systems. Do they work well, and if not, how can they be improved?

Flexibility of the IS Function is Critical for Success. As the IS function continues its inexorable trend of devolution, it is imperative that it maintains a high degree of flexibility. Although IS itself is centrally managed, more and more of its assets (such as data and computers) are being decentralized. The

environment is one where corporate IS sets the standards, and the other groups are implored to adhere to them. But this environment necessitates flexibility on the part of IS; no longer can it freely dictate IS policy. It needs to consider the myriad wants and wishes of sophisticated users. While it is true that IS takes into account the needs of its user communities, the proliferation of technology has led to the general dissemination of IS skills and talents throughout the organization. This creates new opportunities and challenges for IS, and it must be flexible to successfully deal with them. For example, organizational personnel may demand as their right the ability to hook up their PCs to each others and to the mainframe. IS policy must be flexible enough to accomplish their requests.

Connectivity is an Evolutionary Trend. Organizations need to think about connectivity in an evolutionary sense; it changes with time. Tools and techniques which are relevant today, may not be so tomorrow. Organizations need to position themselves in such a way that they are able to take advantage of emerging technologies - both planned and unplanned. This again relates back to the need for flexibility. Nothing in the field of information technology is ever permanent, and connectivity needs to be considered in light of this evolution. It is therefore important for organizations to develop a connectivity policy which allows for change, for it must be realized that change is the most ubiquitous aspect of the field.

Grand Connectivity Technology Plans are Likely to Fail.

Following on from the previous point, an all-embracing connectivity plan is likely to fail simply because not all options can be planned for, new technologies will emerge which will need to be adopted, and business opportunities will emerge which will require substantive IS changes. In such an arena, it makes sense to start small, involve the organization in a variety of pilot projects obtaining as much knowledge and experience as possible during these pilots, and develop evolutionary policies to deal with connectivity. The most effective plan is likely to be one which is evolutionary, flexible, and proactive; one which concentrates more on what is to be accomplished, rather than how.

Plan Realistically. One of the major reasons for failure in the IS field is the development of plans which were unrealistic: unrealistic implementation time frames, unrealistic technological forecasts, unrealistic expectations, etc. Although it would be desirable to have a policy of connectivity in which every technology is linked to every other technology, such a plan is probably unworkable. If such a plan is made public, it would raise expectations to a level which could not be reached; failure would be inevitable. It is therefore prudent to consider the level of expertise on connectivity now available in the organization, consider the past experiences with technologies and user reactions, and such like, in developing a plan which is both sensible and operable. Sensible in the fact that it does not make erroneous assumptions (e.g. that vendors and standards work

in concert; in fact the two are in conflict with one another). Operable in sense of plans which have a realistic chance of success (e.g. not attempting linkages which are beyond the state-of-the-art, particularly if the firm has been relatively conservative in the past). The plan should focus on "solution" rather than "vendor", even though it may be tempting to follow one particular vendor for all connectivity decisions. Concentrating on "solution" generally focuses thinking on business functions and processes rather than the specific technologies of a particular vendor.

Senior Management Support is Critical for Success.

Connectivity needs the support of top management. If they are not visibly supportive of the connectivity policies, it may be difficult to get the rest of the organization to adhere to them. The best way for such support to be obtained is to make the relationship between connectivity and the business plan visible. Senior management are more likely to both understand the need for connectivity policies and supportive of them if they understand their business implications. Thus, they should be linked, wherever possible, to the Corporate Plan - a linkage which should become easier and easier to make (i.e. more obvious) given the important role inter- and intraorganizational connectivity will play in a firm's survivability.

RECOMMENDATIONS

The issue of connectivity is, arguably, more a managerial topic than a technological one. This is not meant to belittle the importance of the technological dimension of connectivity, but to highlight the important organizational nature of the problem. We have sought to show why all organizations need to come to grips with connectivity, what is involved with such linkage, how some organizations have approached the task of connectivity, and suggested some lessons which emerge particularly in area of interorganizational connectivity. While it is not possible to offer an all-embracing action plan for connectivity, we would like to conclude with a broad list of recommendations which organizations might wish to consider in their attempt to manage connectivity.

Think Interorganizationally. While intraorganizational connectivity is vitally important for a firm's survivability, more and more corporations are looking to interorganizational systems as the wave of the future. The examples discussed above are indicative of the future: all the companies involved in EDI feel the only way they will be able to successfully compete in the long term, is with interorganizational systems. EDI is no longer a luxury. Organizations who ignore EDI do so at their peril. This means that firms need to start thinking about where EDI might be appropriate, with which other organizations, and take steps to get the ball rolling. This may mean through pilot projects with one other organization, or with a number of others. It is prudent to consider not simply supplier-buyer applications,

but also competitor-competitor applications such as joint interest billing in the oil industry. Quite often, the more complex the relationship, the greater the potential payoff. Such thinking does, of course, require a change in the thinking of corporate management. One can imagine the soul-searching that must have gone on in the various oil companies boardrooms when the issue of Joint Interest Billing through EDI was discussed.

Companies, because of the increasingly competitive environment brought about by the internationalization of industry, must constantly look for an edge. Technology, particularly through interorganizational systems, is increasingly being considered as the vehicle for providing that competitive edge.

Think Intraorganizationally. In order to effectively consider interorganizational applications, a firm needs to have its internal shop in order. Quite clearly, it would be difficult to deal with interorganizational standards if few existed inside. It is for this reason that organizations need also to consider their internal operation: what processing capabilities are available now, what network capacity is available, how much storage exists, what standards are adopted and to what degree are they followed, what architecture (if any) is in place to allow data interchange, is there a technological infrastructure in place which can be used to effectively develop current and future applications, what support is there from the board for information technology expenditure, is the IS plan in alignment

with the corporate plan, and is IS seen as a strategic resource of the company. Issues such as these need to be effectively dealt with in order for a firm to successfully compete in the future.

SUMMARY

Based on our understanding of the issues surrounding connectivity and the ways a number of organizations have approached the task of dealing with them, we feel that it is absolutely imperative that firms seriously consider this key area. Connectivity cannot be ignored. Yet, there are many, many different ways to deal with connectivity. It would be nice to have a "standard action plan" or "cookbook approach for organizational connectivity"; unfortunately, no such plan is possible. Organizations are too different to have one plan which would be appropriate for all. Nevertheless, the lessons learned should help direct discussion and research towards a general connectivity strategy which would be suitable in particular environments.

While intraorganizational connectivity is vitally important for a firm's survivability, more and more corporations are looking to interorganizational systems as the wave of the future. However, in order to effectively consider interorganizational applications, a firm needs to have its internal shop in order. It would be difficult to deal with interorganizational standards if few existed inside. Issues such as these need to be

effectively dealt with in order for a firm to successfully compete in the future.

Why the Interest in Connectivity?

- Internationalization
- Increased Competition
- Increased Visibility of Success Stories
 - American Airlines
 - McKesson's
 - Merrill Lynch
 - Avis

- Increased Awareness of the Benefits of Inter- and Intraorganizational Linkage



Interorganization

- EDI
- AHSC

Intraorganization

- Image Processing
 - Diners Club
 - John Deere
- Telecomms
 - Ryder Trucks
 - USA Today

Business Case for Connectivity

- The Business Case for connectivity is simply "doing business better". Connectivity makes good business sense.
- Connectivity is thus not just technical, but managerial.

Connectivity

The *effective* joining of two or more *systems* for the purpose of *resource sharing*.

Q-3 All systems are "connectable"; the designer must determine whether the effort is worth the connection.

Lessons Learnt From Case Studies

1. Interorganizational Lessons

- Penetration into Business Processes
- No Formal Cost-Justification
- Vehicle for Rethinking Business Functions
- Competitive Advantage
- Altering Supplier-Buyer Relationships

2. General/Global Lessons

- Connectivity Involves Supporting Human Communication
- Flexibility of IS Function Critical
- Connectivity is an Evolutionary Trend
- Grand Connectivity Plan is Likely to Fail
- Plan Realistically
- Senior Management Support is Critical

Technology Infrastructure #1

- Network Capacity
 - integration of voice, text, image and data
 - high bandwidths needed --> fiber optic
- Workstations
 - need to handle mixed media
 - high resolution, bit-mapped displays
- Storage Devices
 - optical media to handle vast storage needs

Technology Infrastructure #2

- Standards
 - open rather than proprietary --> OSI
 - protocol converters a necessity
- Information Architecture
 - Hardware
 - three level consideration
(individual, department, corporate)
 - Data
 - data structure (relational, network)
 - data sharing between different applications

Recommendations / Conclusion

- Think Interorganizationally
 - supplier-buyer
 - competitor-competitor
- Think Intraorganizationally
 - processing capabilities available
 - network capabilities available
 - storage capabilities
 - standards adopted and followed
 - architectures in place
 - technology infrastructure
 - alignment of IS plan with corporate plan
 - IS as a strategic resource



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